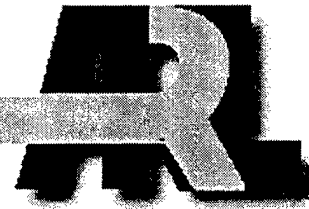


ARMY RESEARCH LABORATORY



Revitalizing Battle Staff Training

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ARL-TR-2079

DECEMBER 1999

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Revitalizing Battle Staff Training

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Abstract

The Depth and Simultaneous Attack Battle Laboratory (D&SABL) and the U.S. Army Research Laboratory (ARL) are in a position to bring advanced training technology into fire support institutional training. Using D&SABL resources to introduce and refine scientifically based learning research findings as well as supporting technology will help guide decisions about resource investments for new technology and further experimentation. Toward that end, D&SABL and ARL conducted an effort funded by the U.S. Army Training and Doctrine Command (TRADOC) Concept Experimentation Program (CEP). The purpose of the experiment was to assess the impact of simulation use on advanced training in the Field Artillery Officers' Advanced Course (FAOAC) at the U.S. Army Field Artillery School and to make recommendations about technology use for advanced training. Our experiment found that advanced technology as used did not impact the learning process or outcomes in the advanced course. Our conclusion was that implementing new technology to support any process without an understanding of the process and its requirements would probably not yield the desired results. Our recommendations included the construction of a learning model that more effectively represents the training needs and reflects the potential contribution of advanced technology, training design principles to implement the model, and technology use recommendations.

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EXECUTIVE SUMMARY

The Military Art of Fire Support Yesterday, Today, and Tomorrow

A face-to-face meeting between brigade and task force fire support officers (FSOs) and the direct support (DS) battalion S3 and fire direction officer (FDO), where the concepts of operations and intents of the various maneuver commanders are discussed will pay rich dividends.

—*National Training Center (NTC) Commander's Memorandum, November 1985*

Communication between the Task Force (TF) Commander and his FSO is critical. If there is a misunderstanding, it will probably not be obvious until the execution commences. The FSO must communicate his thoughts in a language the commander will understand.

—*NTC Lessons Learned Bulletin, January 1986*

Rehearsing a fire plan is no different than war gaming a maneuver commander's concept of operation. This thought process must ensure synchronization of fire support to enhance a maneuver commander's intent of fighting the battle.

—*NTC Lessons Learned, September 1986*

The tactical requirement is for the FSO to be responsive to or, in some cases, under the control of the maneuver commander he supports.

—*Center for Army Lessons Learned (CALL) Bulletin 88-3, Vol 1: Heavy Forces, Fall 1988*

Use the Fire Support Execution Matrix to conduct a fire support rehearsal...Ideally, conduct this rehearsal with a maneuver rehearsal. If the commander does not understand the fire support plan, he will not use it. The fire support execution matrix and the rehearsal overcome this problem.

—*CALL Bulletin 89-1, Non-Mechanized Forces, Spring 1989*

Fire support planning is conducted concurrently as the maneuver force conducts its battle planning... Development of a successful fire support plan is dependent on the maneuver commander's guidance...The most effective method of ensuring that the commander's guidance and intent is clearly defined and understood is for the Fire Support Coordinator (FSCOORD) to brief back his understanding of the commander's fire support guidance to the maneuver commander.

—*CALL Bulletin, 90-1, Fire Support for the Maneuver Commander, February 1990*

Fire support must be integrated with the unit's scheme of maneuver and its surveillance and target acquisition efforts. The fire support systems must be flexible enough to supply conventional fires without interruption as the tactical situation changes.

—*CALL Bulletin, 90-3, The Stone Forest, May 1990*

The [Fire Support Execution] Matrix assists the FSO and maneuver commander in understanding how the fire plan supports the scheme of maneuver and the commander's intent...The FSCOORD and FSO must be able to express the capabilities and limitations of the fire support system in terms the maneuver commander, his staff, and subordinate commanders understand.

—*CALL Bulletin, 90-5, Fire Support Lessons Learned, May 1990*

At brigade and battalion levels, many units do not completely understand or implement the targeting process to develop an attack guidance matrix. Brigade and battalion commanders and their key staff members must get personally involved and support the process. Key personnel should religiously attend and actively participate in targeting meetings. This process leads to fire support synchronization by attacking the right targets with the right assets at the right times. The commander's intent for fires must specify what is to be done to the enemy. Targeting meetings determine "how."

—CALL Combat Training Center (CTC) *Quarterly Bulletin*, 93-4, 1993

Force XXI Operations is centered around quality soldiers and leaders whose full potential is...realized through information age technologies and by rigorous and relevant training and leader development....It describes an operational environment where the acquisition, processing, and rapid sharing of information revolutionizes the conduct and tempo of operations...To win on future battlefields, future leaders...must be skilled in the art of military operation, [and] capable of adjusting rapidly to the temporal and spatial variations of new battlefields.

—U.S. Army Training and Doctrine Command (TRADOC), *Force XXI Operations*, 1994

[By 2020] fire execution will be an inherent function of the systems...fire supporters will focus on assisting the commander primarily with the conceptual aspects of fighting with fires, establishing and refining protocols, intuitive analysis and decision making...Future artillery leaders will require intuitive, tactical judgment to a greater degree than ever before.

—MG Leo Baxter, *Field Artillery Vision 2020*, 1994

Field Artillery battalion tactical operations centers (TOCs) are not synchronizing assets with the maneuver battle. Problem: FA TOCs do not routinely use the Tactical Decision-Making Process (TDMP) to create the products necessary to synchronize fire support with the maneuver battle because the efforts of the respective staff sections are not coordinated by the FA S3.

—CALL *Bulletin*, *Combat Maneuver Training Center Trends*, 1st & 2nd Quarters FY95, 1995

The brigade FSCoord and FSO must develop, with the maneuver commander, clearly understandable and achievable commander's fire support guidance.

—CALL *Bulletin*, 95-1, *CTC Lessons Learned*, February 1995

The brigade targeting team does not synchronize between the battlefield operating systems and fails to develop

- A meaningful high payoff target list
- A war game-derived scheme of fires
- A target list that supports the scheme of maneuver.

—CALL *Bulletin*, *NTC Trends*, 3rd & 4th Quarters, FY95, 1995

Commanders' guidance and intent statements are doctrinally incomplete...Commanders do not use tactical terms to precisely convey the concept of the operation.

Terms of the battle are set by the enemy...[In] defensive operations, fires and obstacles are not synchronized with the scheme of maneuver.

—CALL *Bulletin*, *Battle Command Training Program Perceptions II*, FY95, 1995

Discussion in military affairs [of the **2010-2025** time frame] has centered around the impact of technology on weapon systems, but a more profound level of efficiency will derive from new organizational structures and training strategies that promise to leverage and capitalize the most from new technologies.

—*Army After Next Project, First Annual Report, June 1996*

In **2025**...we must provide commanders robust support from field artillery and other fires platforms not necessarily tucked in their back pocket...All artillery systems should become fire assets integral to combined arms operations for application anywhere in the battle space, in accordance with the commander's intent. They would be managed, controlled, and directed by the highly automated Effects Control Center...We will not only have to manage effects, we will also have to dynamically package them to provide commanders with tactically meaningful options.

—BG Stricklin, *Fires—The Cutting Edge for the 21st Century*,
Presented at the Fire Support Conference, **February 1998**

Problem: Task forces are not conducting sufficient planning in the integration of fires into the scheme of maneuver. During war gaming, FSOs do not understand the scheme of maneuver and what fires are necessary...to support the maneuver plan...Techniques: TF FSOs need a better understanding of how artillery is being used in the brigade's fight. TF FSOs should articulate the use of artillery by the Brigade Combat Team (BCT) to the TF staff during...wargaming...[to] provide [the staff] a better understanding of what close support assets can do to support the TF scheme of maneuver.

—*CALL Bulletin 98-4, CTC Trends, NTC, February 1998*

Situation Assessment

Observations across the U.S. Army since 1985 indicate

- A pervasive lack of synchronization between fires and maneuver,
- A need for better understanding of the planning process as well as adaptation of the process in time-compressed situations,
 - Tactics, techniques, and procedures (TTPs) to fit the fire-planning process to specific maneuver operations,
 - A need for training emphasis on coordination and communication using terminology and methods that work for both fire support and maneuver,
 - The important role of a sufficiently detailed and coordinated fire support execution matrix in planning, preparation, and execution.

Unfortunately, these lessons learned have been cited so many times that they do not have much impact. It is time to change our focus and consider that the findings imply that some core advanced skills are not being consistently taught until proficiency is reached in advanced institutional training or that training does not transfer to the operational environment. The result is that units continue to show the same needs for improvement when they are observed in high-cost unit training or operational settings. There are, of course, other factors (such as unit personnel turbulence) affecting the execution of these skills, but because these appear to be the

very battle staff skills upon which the advantages of the digitized battlefield will rest, training must be re-thought.

Course of Action: Training Revitalization

The purpose of this project was to develop a technology integration strategy based on an articulated learning model that addresses the role of technology. Our central thesis was that the learning model, not technology per se, is the foundation for training re-engineering.

As we look to the future, we cannot depend on the automation of fire support processes alone to reverse these trends. In fact, "spot reports" from the future indicate that envisioned operations will place more stress than ever on the very areas where weak performance has been evident on a continuing basis. A greater level of proficiency must be attained during advanced training, and the carryover to the field environment must be more substantial. This is the contribution that advanced training can make toward setting the stage for future operations.

Continuing technological evolution is creating requirements for entirely new kinds of staff performance. New kinds of performance can only be built with new kinds of training. Mastery of subject matter has become a subordinate task to the overarching goals of knowing how to formulate problems, how an area of knowledge is structured, where to find information, how to manage information, how to share information, and how to respond with agile decisions. Fortunately, the technology that compels us all to process information more quickly, often with several objectives in mind, also brings us new capabilities to learn those skills. New technology does not, however, usually come with simple instructions about how to integrate it into training.

The U.S. Army Training and Doctrine Command (TRADOC) vision of the future of technology for Army training is one of constant evolution in which instructional technologies are adopted and replaced as new advances emerge. To support this evolution, the Army is building a training technology infrastructure, and each major Army command and proponent school is responsible for preparing individual command implementation plans for using that infrastructure. TRADOC has asserted that funding to expedite acquisition of modern training technology "...will provide the foundation upon which *training re-engineering* (emphasis added) is based... TRADOC's goal is to incorporate current media, as appropriate..., and future media as available, into a single hypermedia high-tech instructional platform" (TRADOC, 1996a, p. 2-11).

The Depth and Simultaneous Attack Battle Laboratory (D&SABL) and the U.S. Army Research Laboratory (ARL) are in a position to bring some of that modern training technology

into fire support institutional training. Like state-of-the-art hardware and software, new models of learning also emerge from research and development efforts. Using D&SABL resources to introduce and refine scientifically based learning models and supporting technology will help guide decisions about resource investments for new technology and further experimentation. Toward that end, D&SABL and ARL conducted an effort funded by TRADOC's Concept Experimentation Program (CEP).

We used the Field Artillery Officers' Advanced Course (FAOAC) as the setting to develop the learning model and technology integration strategy. The Fire Support and Combined Arms Operations Department (FSCAOD) of the U.S. Army Field Artillery School (USAFAS) administers the FAOAC and provides instructors who are ultimately responsible for implementing new technology into the residential portion of the advanced course. FSCAOD supported data gathering in this experiment by implementing controls between experimental class sections and non-experimental class sections. Instructors also provided subject matter expert (SME) views about training needs and current and planned media. The project also provided insights into the use of instructional technology in other fire support training and in military training in general.

Field Artillery School Battle Staff Training FY97: New Wine in Old Bottles

To date, a number of new technologies have been introduced into the FAOAC. All classrooms in use provide some multimedia capability. Computer-generated slide presentations can be produced and shown on a large screen display, the instructor has a personal computer (PC) workstation, internet capability is available to students, and a video cassette recorder (VCR) is integrated for easy access to videos and video clips to be shown within a lecture or demonstration. All class sections have access to the Janus simulation for exercises three times within the course. Planning for the exercises takes place in the classroom. Execution of these exercises takes place outside the classroom in the Janus facility. Two classrooms (the experimental classrooms) have the previously mentioned multimedia as well as Initial Fire Support Automated System (IFSAS) emulators and in-class Janus capability for practical exercise planning support. No classrooms can support execution of the practical exercises during class.

Is the technology providing the desired impact on advanced training? We conducted a field experiment to examine the impact of technology introduced into the advanced course to date. We compared (a) the learning process and (b) the performance of students after training between sections with and without advanced technology available in the classroom. It was hypothesized that if classrooms with advanced technology support (the presence of a simulation and tactical

equipment emulation) were improving training, we would see more student interaction, more exploratory behavior (consulting a variety of information sources) during problem solving, and the students would feel more immersed in the process. Differences in the learning process would then lead to better post-training performance by the students using advanced technology during training.

Students were observed in four course sections (two with technology and two without) during three in-class practical exercises. Students were surveyed regarding their perceptions of the learning experience after practical exercises. The measures used indicated that the small group instruction produced satisfactory learning experiences in both settings. There were equally high levels of student-initiated verbal interactions and student information-seeking behaviors during the learning process across settings, regardless of the presence of simulation technology. Differences were found between the two treatment conditions for 7 of 11 survey items. However, all *statistically significant differences were in the opposite direction of that hypothesized.*

Students in the *non-simulation classrooms agreed more strongly* that the practical exercises

- Helped them remember and apply knowledge when needed,
- Prepared them to learn more about operations in the future, and
- Stimulated students to seek and use information.

Students in the *non-simulation classrooms disagreed more strongly* with the following statements:

- The exercise was often boring.
- The exercise wasted too much time.

Post-training data were gathered during the capstone exercise following completion of small group instruction. Ratings were collected about staff initiative, staff communication, staff supporting behavior, information exchange, and seven terminal learning objectives (TLOs) thought by the instructors to be the key tasks in the capstone exercise. There were no significant differences in ratings of student performance by instructors or students' self ratings of their sections' performance between simulation-based classrooms and non-simulation classrooms. Three examinations were given as a part of small group instruction. There were no statistically significant differences between examination scores across settings.

Conclusion

Overlaying new technology onto existing processes will not yield desired gains. The presence of advanced technology in the classroom did not enhance either the process or the outcome of training as measured here. While the technology did not unduly denigrate the learning

process, it could be perceived as a mild training distracter as currently implemented, judged by student perceptions of the learning process.

The literature in business process re-engineering provides insight into technology integration. Process re-engineering outcomes have demonstrated that the introduction of technology alone will not make a difference in how well a process works and the results it achieves. What makes the difference is how well one understands the process one is trying to impact. In many cases, the introduction of new technology into an existing process is like “putting new wine in old bottles.” The result is disappointment with the technology and confusion about why the process and outcomes have not improved.

The findings in this project appear to repeat those found regarding the integration of automation in business and industry. The implementation of technology without substantial thought about the instructional goals and strategy will not be successful.

A Learning Model to Guide Battle Staff Training Revitalization

Given the challenge to battle staff performance, we must re-engineer the learning process to transfer more skills to the field and to understand how to use technology to support that goal. Re-engineering the learning process requires that we develop a model of the desired learning process. The Officer Advanced Course is not like most Army training, and we would not want it to be. To train is to create an expected mode of performance, to create proficiency that meets or exceeds a set standard, to cause someone or something to react predictably during given circumstances. The practice of an art is not wholly predictable. It is based on a firm foundation of techniques, but it goes beyond that foundation in as many unanticipated ways as there are experts and situations.

To verify these assumptions about the high level of learning required in the Officer Advanced Course, we conducted a cognitive task analysis of the program of instruction (POI), a survey of instructors, and a survey of all active field artillery battalions to analyze the learning objectives. Eleven FAOAC instructors were surveyed, and 104 surveys were sent to units. Seventy-two (69%) of the surveys were completed and returned. There was a large amount of agreement between the field perceptions and the perceptions of the instructors about the learning objectives.

Based on the empirical data derived, each objective was rated according to five attributes:

1. The cognitive level at which it is taught;
2. Instructor ratings of the need for face-to-face training;
3. Unit and instructor perceived need for graduate proficiency;
4. Whether battlefield performance of the task is becoming more critical to operations; and
5. Whether the objective is more collective than individual in field performance.

The sequence of learning was also assessed and the objectives were organized in novice-to-expert learning stages. Twenty-three of the 37 objectives comprising small group instruction were found to truly comprise the art of fire support. They are at an advanced cognitive level of instruction, can best be taught in face-to-face training, and require a high level of new graduate proficiency. Thirteen of the 23 objectives are collective in nature, and 5 of the 23 are becoming more critical in operational settings. This project concentrated on the selection of new methods and media to support the effective, efficient acquisition of these advanced skills and the transfer of that institutional learning to the field.

The art of fire support, like any other art, requires judgment, experience, and creativity. These skills can be achieved only by what learning theory calls a "cognitive apprenticeship" with an expert and much experience. To gain proficiency in an art is to learn at the highest level. To introduce a student to this level of learning, we must introduce him or her to the thinking skills that "stretch" the foundation he or she has achieved in the techniques of a domain. We must familiarize the student with and initiate him or her into the rich contexts and team collaboration that are characteristic of the military art. How do we use full-scale simulation to the best advantage? Can we use technology to introduce students to this level of learning and to simulate experience before the use of a full-scale simulation or mentoring from an expert? How do we promote transfer of training to the field?

To answer these questions, we must examine learning models that predict superior outcomes for advanced instruction. Applicable learning theory currently available in the literature is only in the emerging stages of instructional implementation, assessment, and refinement. Theory is emerging in the educational research community, specifically in response to changing learning goals because of technology expansion and to findings about the limited results in learning transfer. Our challenge is twofold: (a) to adapt emerging learning theory to advanced military training, and (b) to use theoretically derived products to assess whether the theory supports full exploitation of technology to produce superior learning process and training transfer.

In this effort, we identified constructivist learning theory as the general area most promising to support advanced military training. It is being used in educational research to guide the integration of advanced technology into education. Constructivists emphasize that learning

must be situated in authentic experiences that motivate the learner to solve intrinsically interesting problems. The theory also emphasizes the need for multiple iterations of complex problem-solving sessions to help the student learn to form hypotheses, see problems from multiple perspectives, and make deep connections among information in context and principles of operation. Constructivism is not a new perspective; rather, it is the increase in the volume of information and new opportunities provided through technology, which have caused a renaissance of this educational perspective.

Cognitive Flexibility Theory is a theoretical refinement within constructivism. Cognitive flexibility refers to the ability to spontaneously restructure one's knowledge in adaptive response to changing situations. Research that stimulated the development of this theory has shown that learning at the higher levels outside actual apprenticeships is often ineffective in the field. Traditional learning often depends on pre-selected generic knowledge structures demonstrated through selected, disjointed cases that have been abstracted and stripped of nuances. This approach is deemed too simple to support the transfer of knowledge to complex situations across cases with much variation.

The authors of the Cognitive Flexibility Theory propose the use of random access instruction to replace abstracted, pre-selected cases. Random access instruction is predicated on the ability of hypermedia to provide access to knowledge domain entry points and paths at the learner's direction. Hypermedia systems facilitate flexible restructuring of instructional presentation sequences through multiple linkages among content items. Hypermedia supports designing for uses that cannot all be anticipated during the design but will evolve as the learner's understanding evolves. Anchored Instruction, another refinement of constructivism, involves placing all instruction in the context of an overarching scenario. Hypermedia is used to facilitate the student's exploration of the larger context and relevant reference material used to solve problems.

In other arenas of military training (e.g., in the Air Force), constructivist approaches to instruction have been investigated, and exploratory products have been generated. Despite a general interest among researchers in revising the instructional strategy of military training, little evidence of change can be found across the services. Elements of a constructivist approach can be found in products from Fort Knox, Kentucky, such as the Mission Analysis Tutor and the Military Decision-Making Process Tutorial. However, the emerging recognition of the need for a constructivist approach to instruction has had little impact as of yet.

Generally, new advanced training products continue to be produced without much, if any, substantiation of their intended effect on training outcomes or of their effectiveness in operation. Technology continues to drive the training design instead of being used to serve the design.

It's Not Just Technology; It's What You Do With It

Aren't We Already Doing Something Like This in Battle Staff Training?

Army training, with its emphasis on experience and "train as you plan to fight" perspective, has integrated some of the principles of constructivism, although without a conscious articulation of a learning model. However, the implementation is incomplete. There are some missing pieces in the way advanced training is currently designed and executed.

While the Army strives for authentic training situations through the use of simulations in unit and institutional training, an opportunity to explore the rich context of a battlefield situation is only occasionally available. Technology has not yet been used to introduce students to the complexity of cognition and collaboration in the battlefield environments outside full-scale simulations. In rich environments, such as our Combat Training Centers, expectations for expert performance are high. This limits the opportunities for sustained exploration of the environment that may be an appropriate learning mode for many "non-expert" training participants who are present.

We are not supporting enough group problem solving in learning situations before full-scale, high-cost simulations. We do not reinforce the absolutely essential tasks of communicating intentions, priorities, and capabilities. We do not provide low-cost opportunities for training participants to explore situations from several perspectives and to develop an appreciation for the level of collaboration necessary for success. We rely on disjointed and abstracted cases instead of presenting rich situations. We need to provide challenges and guidance for trainees to work through complex situations and link lessons learned to context. We must make improvements to (a) use simulations and operational lessons learned to structure problem-solving sessions for the advanced student, (b) structure observation of complex settings for novices, and (c) use technology to stimulate thinking skills before simulation training.

New Wine in New Bottles

As the result of the Fiscal Year 1997 CEP effort, we assert that we must use research and development to revitalize battle staff institutional training. This revitalization starts with further development of the theoretically derived learning model. It is not feasible for the

development of innovative instruction or for the migration of current instruction to new techniques to be accomplished by the U.S. Army's current training developers. Training developers build instructional materials, based on a firm grasp of current methods derived from behavioral science. Innovation, and thus success, depends on the extrapolation of emerging learning theory to devise new design and development methods. Developers are not behavioral scientists. Model products must be developed to extend and test theory, and developers must then be trained in new instructional design, not just in new media use.

A paradigm shift is taking place in learning models, and some elements of the new paradigm are already in place in advanced military training. A full implementation of new learning models, rather than simply automating existing training, will provide the foundation for faster, more effective training.

Proof-of-Principle Products

"If you can do one thing in this project, tell us how to use Janus better"

—BG Lennox, U.S. Army Field Artillery School, Assistant Commandant, 1997.

What constitutes "better" use of a simulation or any advanced technology is an empirical question. We can use this project to point the way toward better use of simulations for advanced training, but the way is multi-faceted. The development of technology, learning theory, and demonstrations of impact is a simultaneous process. The preparation of an authentic context built around the simulation and the preparation of students before full-scale simulation training must both be addressed.

As a result of the Fiscal Year 1997 CEP, we have proposed the development of proof-of-principle products to demonstrate the learning model, to test the assumptions of the underlying theory, and to provide models for the training development community. Experimental products include the development of an overarching scenario supporting multiple vignettes in advanced training. The interrelated vignettes would provide an opportunity for sustained exploration of concepts and deep learning inside and outside the simulation setting. We have also proposed the development of computer-based cognitive skills training, also set in a rich context, to precede participation in full-scale simulation. Such PC-based training in advanced cognitive skills in military environments is basically non-existent today. However, new technologies such as "wizards," powerful PC-based authoring tools, linkage of interactive databases to graphical interfaces, and random access to information through hyperlinks now make it possible to move in that direction.

Conclusion

Several forces are coming together at once, which impact the future of advanced, officer institutional training. These forces are

- The need to standardize advanced training across active, guard, and reserve components.
- The need to limit expensive, residential training and the growing possibility that if training can be standardized and administered at a distance for reserve and guard components, the same can be done for the active component.
- Continued improvements in simulation technology and the ability to distribute them over wide geographical areas.
- The "umbrella" efforts of the Army Distance Learning Plan to facilitate training re-engineering by creating a high-tech instructional platform to serve Army-wide training.
- Force XXI philosophy directing the Army to maximize information technology on the battlefield.
- Advances in information technology that create new learning and communication goals across a number of human endeavors.
- Advances in instructional technology and theory that make new learning processes possible so that new goals can be met by mirroring and supporting the learner's cognitive processes more closely than ever.

To exploit these various forces and use them to bridge the way to future enhanced performance requires a strategy. The results of this CEP demonstrate that the introduction of new technology into the training process without a strategy to improve that process does not lead to the desired outcomes. The literature provides us with an alternate approach by providing theory regarding the most effective model for advanced training and by specifying the role of technology in that model.

Implementation of new theory will be challenging because few models are available, and the theory is somewhat in opposition to the traditional military training development process at lower levels of training. Yet, training in simulation environments throughout the military has been moving toward this new paradigm in advanced training for some time. To maximize this evolution, we must complete the picture by fully articulating the underlying training strategy, that is, making the theoretical underpinnings explicit and using them to guide and assess development decisions and technology implementation procedures.

REVITALIZING BATTLE STAFF TRAINING

INTRODUCTION

This report documents a Concept Experimentation Program (CEP) effort designed to support the successful integration of automation and simulation into the U.S. Army Field Artillery School's (USAFAS) Field Artillery Officer Advanced Course (FAOAC). The effort was funded by the U.S. Army Training and Doctrine Command (TRADOC). The CEP was executed by the Depth and Simultaneous Attack Battle Laboratory (D&SABL) and the U.S. Army Research Laboratory (ARL). The objective of this project was to develop a mid-term and long-term technology integration strategy for modernizing the instructional technology used in the USAFAS classrooms. This report documents the analysis done to support development of the strategy and provides the recommended strategy.

The first section of this report contains a review of the lessons learned that alert us to the need for changes in advanced training and the potential impact of continued ineffective performance on future operational capabilities. The remainder of the report describes our analysis of advanced training requirements in the area of fire support (FS) and methods to implement recommended changes derived from that analysis.

THE MILITARY ART OF FIRE SUPPORT YESTERDAY, TODAY, AND TOMORROW

Thirteen Years of Lessons Learned

Lessons learned compiled by the Center for Army Lessons Learned (CALL) from 1985 through 1992 were reviewed and cross walked with a series of task analysis studies covering fire support and field artillery (FA) completed by the Army Research Institute (Kastanek & McIlroy, 1993; McIlroy, 1994; McIlroy, Mullen, Dressel, & Moses, 1996). The task analyses were created to support the development of a training strategy for field artillery. The analyses detail the tasks, products, and processes required to employ field artillery and to coordinate fire support.

The review of the lessons learned by Kastanek and McIlroy (1993) was at the task force (TF) level for field artillery. Lessons learned emphasized the maneuver commander's primary responsibility for a successful fire plan by articulating the fire support role in the overall operation. To fulfill this responsibility, communication between the fire support officer (FSO) and the TF commander is critical. Use of terminology that adequately describes fire support

capabilities in language the maneuver commander can use is key. Generally, coordination and communication are emphasized in lessons learned from the planning phase of battle such as

- The use of the S2 (intelligence) situation template to develop and refine the target list,
- The communication of capabilities and limitations between the engineer and the FSO,
- The need for training of S2s and FSOs to develop the reconnaissance and surveillance plans and fire plan together,
- Effective communication between observers and FSOs,
- The role of the maneuver commander in assuring that subordinates know how the fire plan and the battle plan are synchronized.

In the preparation phase of battle, lessons learned emphasized the fire support coordinator (FSCOORD) or FSO briefing to the maneuver commander about how fire support will accomplish the stated and implied missions. The quality briefing is explicitly described, indicating the essential details needed for effective communication. Rehearsals are also emphasized, with the keys to an effective rehearsal specified. Concurrent rehearsal of many plans and sub-plans is advised to enhance communication and coordination. Lessons learned in the execution phase emphasized effective communication among the FSO, the fire supporters, and the maneuver commander.

The task analysis for coordination, synchronization, and integration of fire support (McIlroy, 1994) was also conducted at the TF level. In addition to the lessons learned just cited, this analysis emphasized lessons learned in the planning phase about war gaming, ownership of the fire support plan by the maneuver commander, and the fire support execution matrix.

War gaming is an opportunity for the commander to decide how fire support resources can best be used, and it is the role of the FSO to provide clear and current information regarding all fire support elements. The FSO must have a good grasp of maneuver doctrine, tactics, techniques, and procedures (TTPs) for all battlefield operating systems. In addition, other fire support personnel must be trained and ready to fulfill this role if needed.

"In a time-sensitive operation, the fire support execution matrix can stand alone to portray graphically the support needed to achieve the commander's intent" (lesson learned cited by McIlroy, 1994, p. 85). The fire support execution matrix can also serve as an excellent tool for the FSO to explain the fire support plan to the maneuver commander. Although the fire support execution matrix may be considered a task that should be mastered in advanced training, the number of related issues cited seem to indicate suboptimal implementation in training exercises.

The task analysis for coordination, synchronization, and integration of fire support at the brigade level (McIlroy et al., 1996) also assessed lessons learned from 1985 through 1992. This study also emphasized in the planning process (a) the need for fire support planning and the maneuver force battle planning to occur jointly, (b) the use of intelligence preparation of the battlefield (IPB) information by the FSO for target list development, (c) the role of the FSO in war gaming with the maneuver staff, (d) the importance of the briefing, and (e) the need for better implementation of the fire support execution matrix.

Preparation phase lessons learned at the brigade level emphasized the need for (a) updates based on reconnaissance, (b) coordination among the brigade FSO, battalion fire direction officer (FDO), and S3 (operations), (c) thorough communication of the fire support execution matrix to key staff, (d) the FSO role in supporting the maneuver commander's visualization of the battlefield, and (e) rehearsal of the fire support plan with maneuver. "The successful execution of a fire plan is directly proportional to the amount of prior planning and rehearsing. Units, as a whole, plan and coordinate fire plans well, but very few units take the time to rehearse them with the maneuver plans" (lesson learned as cited by McIlroy et al., 1996, p. 13-16).

Execution lessons learned were similar to those cited before and also emphasized the role of coordination and communication. "FSOs must be aware of the limitations boundaries imposed on their planning. Failure to pay attention to boundaries is the second most common cause of fratricides...[P]assive control (silence is consent) greatly increases the potential for fratricide, due to the assumption of optimal communications and battle tracking" (lesson learned as cited by McIlroy et al., 1996, p. 13-25).

CALL publications were reviewed to update the analysis to 1998. The Joint Readiness Training Center (JRTC) published training trends and observations for the second quarter of 1995 (CALL, 1995), which included insights into applying the top-down fire planning process. Practice of this process at JRTC highlighted a need for a better understanding by units of the key elements of the process.

The top-down fire planning process "was first introduced for planning fires at brigade and below in a series of articles published in the *Field Artillery Journal* in 1989..." but by 1995, the process was still not well understood in the field, according to JRTC observations (CALL, 1995, p. 12). Lessons learned indicate top-down fire planning has proved to be the underpinning of successful operations only when certain fundamental elements are followed.

The JRTC observations indicated that "the brigade FSCoord and FSO must develop, with the maneuver commander, a clearly understandable and achievable commander's fire support guidance," (CALL, 1995, p. 12). The method suggested was to relate a specific purpose for each fire support asset (i.e., mortars, naval gunfire, etc.) to each phase of the operation to provide guidance for all subordinate maneuver commanders and the fire support community. JRTC noted that the fire support execution matrix can only be considered detailed enough if it can be used as the primary rehearsal tool for both maneuver and fire support. Targeting meetings during course of action analysis and during execution are critical to the top-down fire planning process so that commander's intent is achieved, not just fire support guidance. Finally, resource allocations must include lethal and nonlethal field artillery munitions, targets, close air support, naval gunfire, and electronic warfare (EW) assets. Smoke and munitions must be related to minutes available.

While these elements of the planning process may seem overly fundamental to some readers, attention to the fundamentals is crucial to successful fire support as continuing field observations show. The top-down fire planning process, specifically the targeting meetings, continued to be an area cited for training emphasis by the JRTC. In a later publication (CALL, March 1997), observations from JRTC prompted an article devoted specifically to the conduct of targeting meetings. This article reflects the script of a training videotape available from JRTC. The targeting process article discussed how to prepare for the meeting, what products to expect as a result of the meeting, how to time the meetings, and the issuance of the subsequent fragmentary order. "Integrated, synchronized, and focused combat power relies heavily on the targeting process...The members of the targeting team must be familiar with their roles and the roles of other team members" (CALL, March 1997, p. 37). The emphasis again is on synchronization through the ability to accomplish thorough communication between fire support and maneuver.

Two 1997 CALL newsletters cited recent lessons learned from the National Training Center (NTC). One of the publications cited trends in strengths and weaknesses grouped by battlefield operating systems (BOS) for the first half of fiscal year (FY) 1997 (CALL, August 1997). No positive performance trends were cited for fire support in this 6-month period. One of the three performance areas needing emphasis (the clearance of fires) is relevant to this analysis because it also emphasizes the role of coordination and communication skills for success. A lack of clear, graphical control measures in the brigade and task force plan to facilitate clearance and no standardized procedures for positively clearing fires across the brigade have led to indirect fire fratricides, as well as task force delay in mission processing times. It was recommended that

(a) the use of maneuver graphical control measures and fire support coordination measures (FSCMs) be improved, and (b) procedures to ensure responsive fires that avoid endangerment be practiced.

The other 1997 newsletter was dedicated to warfighting techniques and procedures for fire support (CALL, August 1997). An article in this newsletter asserts that there is no standardized clearance-of-fires procedure for brigade. Units in training at NTC have attempted a variety of methods, none of which have been completely effective. Units were admonished never to clear fires from situation maps because the maps will never be accurate enough. A suggested procedure that was detailed in the newsletter includes the need for a clearance-of-fires battle drill.

The lead article in the same newsletter attributed problems synchronizing fires and maneuver at the battalion and TF level and below to a lack of published fire support doctrine to support key maneuver tasks. The article asserts that FSOs are not familiar with doctrinal maneuver manuals that adequately address maneuver operations such as Field Manuals 71-1, 71-123, and 90-13-1. (These field manuals *are* included in the student issue for FAOAC.) The article suggested the creation of more TTPs, checklists, charts, and matrices at the TF level by Combat Training Center (CTC) subject matter experts (SMEs), small group instructors, and USAFAS to foster synchronization. A number of examples, such as a fire support considerations checklist for defensive operations and a checklist of fire support requirements for breaching operations, were developed and included in the article.

Another article in the 1997 newsletter also addressed synchronization through the proposal of a modified TF level fire support planning methodology. Modification was needed because the TF commanders were not getting timely, accurate indirect fires because of their inability to understand their role in fire support planning, to clearly articulate what they wanted the fires to do, or to visualize the synchronization. The proposed fire support planning solution was part of an abbreviated planning process being developed at NTC because of the time compression factor at the TF level.

Rehearsal was also addressed in the newsletter. "Rehearsals are not the quality product that we desire because we do not plan for them to be...Doctrinally, the requirements and importance of rehearsals are clear. What is lacking is an actual 'how to'..." (CALL, August 1997, p. 40). A fire support standing operating procedure (SOP) was proposed to provide a framework for inclusion in the unit tactical SOP. The TTPs proposed were developed at NTC, based on hundreds of tactical missions observed.

As recently as February 1998, similar lessons were still cited. In the *CALL Bulletin 98-4, CTC Trends* (CALL, 1998), TFs were cited for not conducting sufficient planning of the integration of fires into the scheme of maneuver. "FSOs do not understand the scheme of maneuver and what fires are necessary...to support the maneuver plan" (p. 27).

In summary, the lessons learned cited indicate both training and doctrinal development needs. The key lessons learned are that there is

- An ongoing lack of optimal synchronization between fires and maneuver;
- A need for a better understanding of the planning process or adaptation of the process in time-compressed situations, and TTPs to fit the fire planning process to specific maneuver operations;
- A need for training emphasis on coordination and communication using terminology and methods that work for both fire support and maneuver (including an emphasis on targeting meetings);
- A need for methods and training for rehearsal;
- A need for an emphasis on the role of the FSO in facilitating synchronization, but a clear placement of synchronization responsibility on the maneuver commander;
- Not enough emphasis on the important role of a sufficiently detailed and coordinated fire support execution matrix in planning, preparation, and execution;
- Not enough coordination between the FSO and the S2; and
- An urgent need for methods and training to improve clearance of fires.

Exercise findings from the March 1997 advanced warfighting experiments (AWE) as summarized by ARL (Leedom, 1997) also indicated problems that may be at least partially corrected through training. Among issues cited were information overload, fratricide, and general failure to optimize the presumed advantages of the digitized battlefield in terms of lethality, survivability, or operational tempo. Information overload seemed related to a lack of understanding about the links among critical information elements, key decisions, and the staff decision-making process, as well as the ability to generally manage increased information flow. Both the CALL findings and the AWE findings indicate individual, small staff group and full battle staff training performance problems.

Future Operational Requirements

Development of advanced training must take into account current operational deficiencies, such as those cited previously, as well as emerging requirements. A number of changes in the operational environment are envisioned for the early 21st century. Relevant projections are discussed in this section.

The framework for the evolution of U.S. Army operations into the 21st century is provided by *Force XXI Operations*, TRADOC Pamphlet 525-5 (TRADOC, 1994). The pamphlet is the intellectual foundation for Force XXI, not doctrine. The concepts are being developed and tested at this time by TRADOC's Task Force XXI, battle laboratories, doctrine writers, combat developers, and trainers.

Force XXI Operations is centered around quality soldiers and leaders whose full potential is...realized through information age technologies and by rigorous and relevant training and leader development...It describes an operational environment where the acquisition, processing, and rapid sharing of information revolutionize the conduct and tempo of operations. —TRADOC, 1994, Preface

The pamphlet continues the evolution of *fully dimensional operations doctrine* adopted by the Army in 1993, which *stresses principles to be learned and understood and relies on the art of battle command to apply those principles in scenarios as they occur (which cannot all be predicted)*. This doctrine is a radical shift from the prescriptive, analytical, deterministic approach to doctrine appropriate to the Cold War. The current and projected strategic environment will likely necessitate the handling of a variety of situations, including many outside Western convention where current Western paradigms will not suffice. More than ever, there are no prescribed "schoolhouse" solutions. "To win on future battlefields, future leaders...must be skilled in the art of military operation [and be] capable of adjusting rapidly to the temporal and spatial variations of new battlefields" (p.2-8).

Shared situational awareness as the platform for battle space command and coordination is emphasized in *Force XXI Operations*. It is assumed that improvements in technology will create integrated, digitized images "that can be displayed graphically in increasingly mobile and 'heads-up' displays" (p. 3-4). *Interpretation and decision making* based on such shared awareness are, however, a training and exercise function. Shared concepts, principles, and terminology will facilitate shared coordination efforts. These factors are not the automatic effects of training in a digitized environment but must be incorporated into training.

To benefit from changes in information technology and information sharing is not easy. Technological changes drastically increase the amount of and access to information. Technological changes also impact the way people think, organize, learn, and communicate. The Force XXI concepts recognize that seeking opportunity within the information technology revolution requires not only planning but also new levels of individual and organizational flexibility. The revolution also creates potentially new vulnerabilities that could nullify the advantages of technology.

Vulnerabilities will result and technological advantages will be lost if there is an inability to prioritize information and conceptually share a common, relevant picture of the battle space; if operational principles are not well understood across a variety of situations to increase rapid and flexible application; and of course, if there is an inability to manipulate, isolate, or negate portions of the electromagnetic spectrum while protecting our own information operations. Failure to correct the current lack of synchronization between fires and maneuver pose another potential vulnerability.

The relationship between fires and maneuver will continue to evolve as simultaneous strikes throughout the battle space increase and maneuver is physically massed for shorter periods of time. "The main imperative guiding future operations...will be to gain information and continued accurate and timely shared perceptions of the battle space" (p. 3-3). The pre-eminence of communication skills (such as targeting meetings, briefings, FSO's use of S2 information) that are already in need of training emphasis is only increasing.

Force XXI Operations expect training events to include routine analysis of operational lessons learned. The interconnection among institutional training sites and between the institutions and unit training is expected to increase the quality of training. Although not explicitly stated as such, training must produce flexibility of doctrinal application across a variety of unpredictable situations for which we have no current "patterns" of practice. To achieve this outcome, training must expose soldiers earlier and more consistently to a variety of expert performance.

Force XXI is seen as the Army's current process of change. The Army after next (AAN) concept provides a long-range vision of what the Army will become after 2010, connects the vision to research and development, and links the Army's concepts to the futures programs of other services. AAN relies on the most modern future projection capabilities available and has been operationalized as an annual cycle of workshops, war games, and conferences.

AAN focuses on four broad areas according to the first annual report on the project (TRADOC, 1996c):

- The geostrategic setting of 2025
- Human and organizational issues
- Evolution of military art to 2025
- Technology and trends to 2025

Four assumptions guided the AAN project:

- Wars will continue to be geopolitically based.
- State-on-state conflict will continue to be the *raison d'être* for the maintenance of military forces.
- The Army has to win wars as well as battles.
- *Human and organizational behavior will dominate technology* (emphasis added)

We are concerned in this study with the AAN aspects of human and organizational behavior and their connection to technology, especially in the military art. AAN recognizes that despite the quantity of discussion regarding the impact of technology on weapon systems, *the "...more profound level of efficiency will derive from new organizational structures and training strategies that promise to leverage and capitalize the most from new technologies"* (emphasis added) (TRADOC, 1996c, p. 8).

- Military output and efficiency will be measured less by aggregate firepower than what will be, in effect, a service sector output; that is, the ability to
- Think, decide, and act quickly enough to control the tempo of operations.
 - Allocate firepower accurately and efficiently.
 - Allocate forces effectively at least possible cost.

—TRADOC, 1996c, p. 8-9

AAN asserts that the art of war as practiced by the U.S. Army will probably meet the challenges of the next century, although some shifts in practice are predicted. First, the operational level of war will become more important and may be practiced somewhat differently as responsibility for theater-level defense becomes more diffuse among a number of agencies. "The practice of operational warfare in the future will emphasize identifying and attacking decisive points as a means to destroy the enemy's center of gravity, without becoming embroiled in pitched battles..." (p. 17). Precision weapons may fundamentally alter the balance between offensive and defensive warfare in ways not foreseen. Second, war will become more difficult to confine geographically, and theaters as currently understood may become obsolete as a way to focus command and control measures during conflict. The availability of long-range weaponry

and precise guidance systems may end safe havens for force staging even in the United States. More emphasis will be seen on protective tactics.

Urban warfare is predicted to become increasingly more common by 2025. Urban warfare presents a technological challenge in that enemy occupation of areas with densely structured buildings can negate many of the technological advantages of the U.S. forces. AAN calls for a concomitant increase in new technologies and techniques for urban warfare.

The field artillery vision for the first part of the 21st century was conceived in 1994 and was documented in the article, "Field Artillery Vision 2020" (Baxter, 1994). In his vision statement for field artillery, Baxter emphasized the pivotal role of commanders at all levels, specifying their information requirements. Specification of information needs will provide the "filters" to create a tailored view of the battle space. This view will result in expanded battle space awareness as the situation is shared in a graphic format simultaneously to commanders at every level. The shared battle space awareness is expected to create a seamless combat arms team with unified command of fire support and maneuver.

"The capability to strike with unprecedented speed will break the current fire support paradigm...Fire execution will be an inherent function of the systems in the unified force..." (Baxter, 1994, p. 13). The role of fire supporters will change from a primary focus on processing every mission to the primary focus being to assist the commander with the conceptual aspects of fighting with fires. *"Future artillery leaders will require intuitive, tactical judgment to a greater degree than ever before"* (emphasis added) (p. 13).

The unprecedented autonomy of the individual soldier at all levels is also stressed by Baxter. The ability to be an independent decision maker is assumed to be supported by the shared situational awareness at all levels. Improvements in technology will greatly increase the expectations of the individual soldier. Unfortunately, these expectations will probably increase much more quickly than the supporting technology will advance. Perhaps the predicted technology will never communicate the real-time shared awareness that is anticipated. The changes in battle space will continue regardless of the advances in other technologies. These changes will place the individual soldier on the widely dispersed battlefield in a role of decision making in ambiguous and possibly under-informed circumstances. *In the mid and long term, only training that "stretches" and exercises the cognitive flexibility of the soldier to conceptualize novel, rapidly shifting situations will prepare him or her for the possibilities of the future.*

Conclusion

Observations across U.S. Army settings since 1985 indicate

- A pervasive lack of synchronization between fires and maneuver,
- A need for better understanding of the planning process as well as adaptation of the process in time-compressed situations,
- TTPs to fit the fire planning process to specific maneuver operations,
- A need for training emphasis on coordination and communication using terminology and methods that work for both fire support and maneuver,
- The important role of a sufficiently detailed and coordinated fire support execution matrix in planning, preparation, and execution.

Unfortunately, these lessons learned have been cited so many times that they do not have much impact. Thirteen years of observations regarding a lack of planning, a lack of common terminology, and problems with rehearsal have not stimulated remediation of this problem. It is time to change our focus and consider that the findings imply that some core advanced skills are not being consistently taught until proficiency is reached in advanced institutional training or that training does not transfer to the operational environment. The result is that units continue to show the same needs for improvement when they are observed in high-cost unit training or operational settings. There are, of course, other factors (such as unit personnel turbulence) affecting the execution of these skills, but because these appear to be the very battle staff skills upon which the advantages of the digitized battlefield will rest, training must be re-thought.

COURSE OF ACTION: TRAINING REVITALIZATION

As we look to the future, we cannot depend on the automation of fire support processes alone to reverse these performance trends. In fact, "spot reports" from the future indicate that envisioned operations will place more stress than ever on the very areas where weak performance has been evident on a continuing basis. A greater level of proficiency must be attained during advanced training in the areas of conceptualization of operations, communication, and coordination. The carryover of training outcomes to the field environment must be more substantial. This is the contribution that advanced training can make toward setting the stage for future operations.

These requirements lead to new learning goals for advanced training. Mastery of subject matter has become a subordinate task to the overarching goals of knowing how to formulate problems, how an area of knowledge is structured, where to find information, how to manage information, how to share information, and how to respond with agile decisions. Fortunately,

the technology that is creating greater emphasis on these skills also provides us new capabilities to learn those skills. New technology does not, however, usually come with simple instructions about how to integrate it into training.

TRADOC has authored a plan to exploit new technology in training. TRADOC's vision of the future of technology for Army training is one of constant evolution in which instructional technologies are adopted and replaced as new advances emerge. (For a discussion of this and other current training initiatives, see Appendix A.) To support this evolution, the Army is building a training technology infrastructure, and each major Army command and proponent school is responsible for preparing individual command implementation plans for using that infrastructure. TRADOC has asserted that funding to expedite acquisition of modern training technology "...will provide the foundation upon which *training re-engineering* (emphasis added) is based" (TRADOC, 1996a, p. 2-11).

D&SABL and ARL are in a position to bring some of the emerging training technology into fire support institutional training. Like state-of-the-art hardware and software, new models of learning also emerge from research and development efforts, and they must be concurrently introduced with technology, just as new weapon systems require new TTPs. Using D&SABL resources to introduce and refine scientifically based learning models along with technology will help guide decisions about resource investments and will inform the design of experiments to assess the impact of new technology. *The central thesis of the current project is that a learning model, not technology per se, is the foundation for training re-engineering. The learning model precedes and guides the implementation of new technology.*

To derive an action plan for revitalizing training using emerging technology, we addressed the following questions:

- How can we describe advanced training objectives and current technology in fire support battle staff institutional training?
- What is the impact of technology as currently used?
- What state-of-the-art training methods and technology should we use to exploit the capabilities of the technology to meet our requirements?
- How do we bridge the gap?

FAOAC was the setting used to develop the learning model and technology integration strategy. The Fire Support and Combined Arms Operations Department (FSCAOD) administers the FAOAC and provides instructors who are ultimately responsible for implementing new technology into the residential portion of the advanced course. FSCAOD

supported data gathering in this experiment by implementing controls between experimental class sections and non-experimental class sections. Instructors also provided SME views about training needs and current and planned technology.

The FAOAC is 20 weeks long, according to the program of instruction (POI). The POI states that the purpose of the course is “to prepare field artillery officers for duties as fire support officers at maneuver battalion and brigade level and duties as staff officers at FA battalion, division artillery, and FA brigade level, and battery command.” The scope of the course is “technical and tactical skills needed to provide effective and timely fire support for Army operations doctrine; fire support systems for levels of command from battery to corps; combined arms operations; threat forces and doctrine; combat service support; leadership; and command and control” (USAFAS, FAOAC POI, 7 May 1996, Preface). According to the instructors, the course is specifically designed to train soldiers in the following four jobs: task force FSO, brigade FSO, field artillery battalion staff member, and battery commander.

Figure 1 illustrates the structure of the FAOAC. “Cuts” in hours indicated in the figure refer to reductions in hours effective in Fiscal Year 1999. The blocks of instruction evaluated include the fire support, field artillery, and the joint application (also referred to as special situations) blocks—about 7 weeks of instruction. The fundamentals and battery command blocks of small group instruction were not included in this study. Additional portions of the course, which were taught in large group instruction by the Gunnery Department and by other departments in FSCAOD and administered separately from the small group instruction, were not included for study here either. The small group blocks of instruction selected for evaluation were chosen because of the existing integration of a simulation into those portions of the POI and because of the belief that the learning objectives were at a high cognitive level of training and required a high level of performance once the student moved to a unit assignment. As noted by COL Coffman, Director, D&SABL, Ft. Sill, Oklahoma, at the time of this experiment, we chose to evaluate the portion of the course relevant to the “art” rather than the science of fire support. The brigade-level capstone exercise that follows the blocks of instruction reviewed was used to evaluate the outcome of training for students taught with different levels of automation and simulation.

There are currently seven class rotations of FAOAC per FY. Each class consists of four sections. Sections of the small group instruction are taught in both Level 1 and Level 4 classrooms that differ in the level of multimedia integration. Level 1 classrooms are designed to support traditional, instructor-led training. Level 4 classrooms are designed to support student-

centered learning and to incorporate a simulation that is integrated throughout the training. (For a more complete description of classroom levels, see Appendix A.)

Large group*		Small group instruction*					
6 wks	2 wks	10 weeks				1 wk	1 wk
Gunnery	I F S A S	Funda- mentals & Battle Analysis 43 hrs Cut to 36 hrs	Fire Support 149 hrs Cut to 135 hrs	Field Artillery 110 hrs Cut to 101 hrs	Joint Applica- tions 45 hrs Cut to 41 hrs	C A P S T O N E	Btry Cmd 44 hrs Cut to 39 hrs
296 hours cut to 260 hours		*hours shown are for FY97 and will be reduced for FY99					

Figure 1. Structure of the field artillery officer advanced course.

This project evaluated the FY 1997 classroom capabilities and training requirements for FAOAC in relationship to emerging requirements and advances in instructional methods and media. Specifically, a “baseline” of current tasks, methods, and media in use in FAOAC was documented. An experiment was conducted to determine the impact of simulation and automation currently used in class on the learning process and the impact on subsequent task performance in a Janus-based exercise. Literature detailing the use of automation and advances in instructional methods was reviewed. We identified needs for additional methods and technology in advanced training. The findings were integrated into recommendations with mid-term and long-term features. An overview of the approach is shown in Figure 2.

Method to Assess Current Battle Staff Training in the Field Artillery School

There is no agreed-upon methodology to identify alternate training approaches, assess the impact of changes, or assess costs in the Army (Winkler et al., 1993). Studies addressing these issues have employed varying methodologies.

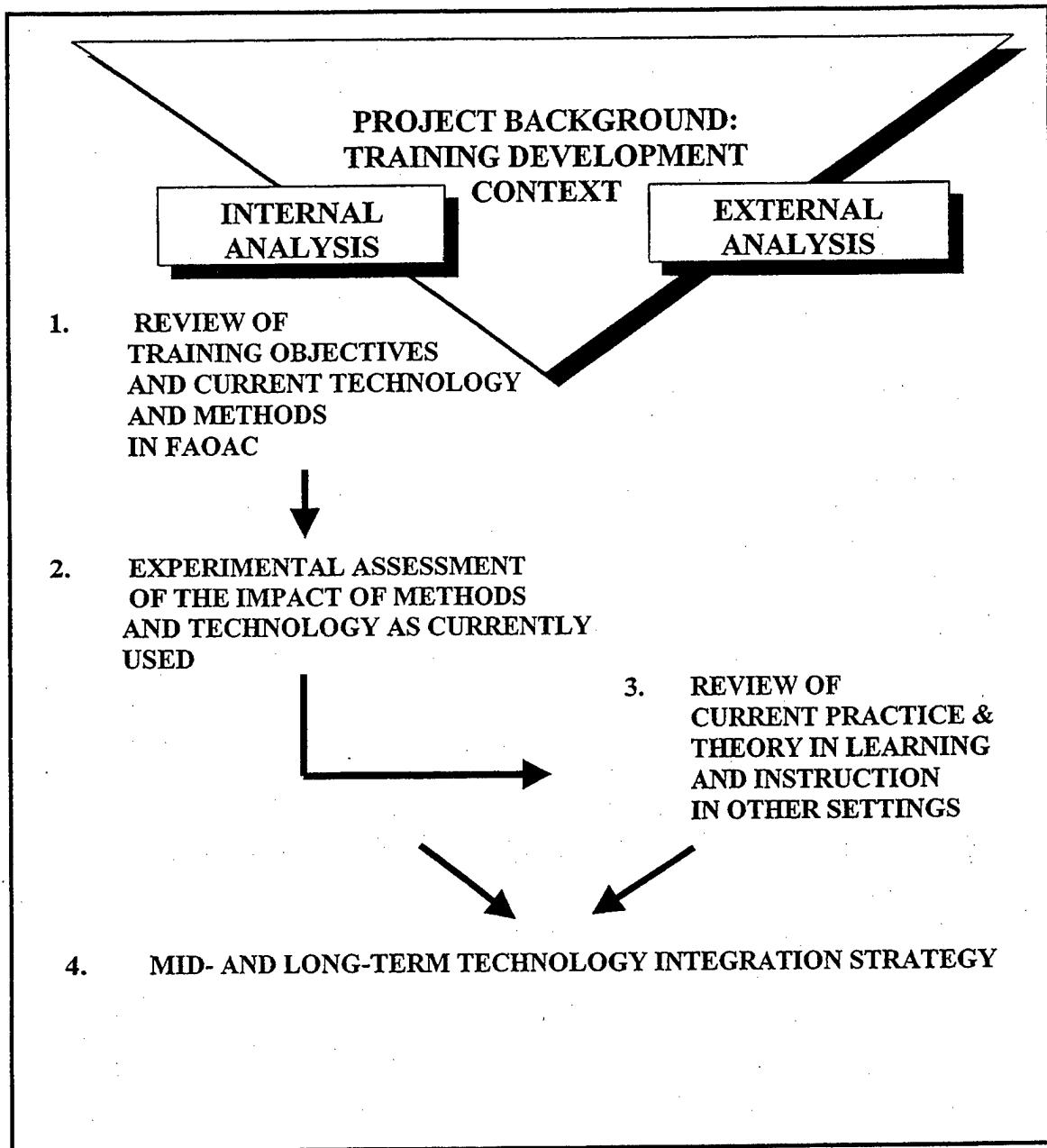


Figure 2. Overview of the project methodology.

Two studies are particularly relevant here. First, Rand's study of the Armor Officer Advanced Course (Winkler et al., 1993) used the following methodology. A job analysis was performed (including measuring attributes of the tasks and grouping the tasks into four major dimensions). The baseline of current course instruction was defined. How alternatives would be

implemented was described in detail, along with the analysis of resource requirements and calculation of specific costs. The study focused on the implementation of distance learning (DL).

A recent study of FAOAC (Hill, 1997) used the following methodology to determine which tasks were most appropriate for DL. The study reviewed distance training in the military and other domains; analyzed the type of tasks in which distance implementation was most successful; compared FAOAC tasks with resulting criteria; administered an attitude survey among senior Army leaders and instructors regarding DL; and surveyed current FAOAC students' computer capabilities and attitudes toward DL. In both of these studies, the purpose was to identify which advanced officer residentially taught tasks could be converted to DL in a cost-effective manner and without loss of training effectiveness.

Both studies provide an approach to task categorization, with the purpose being to organize tasks for DL. Neither study examined investments and improvements in the remaining residential portion of the respective advanced courses to maximize the intensified (condensed time and higher level of task performance expected) small group instruction.

Review of Learning Objectives

A review was conducted of the tasks in FAOAC small group instruction, specifically the training objectives in Annex B of the POI, excluding the fundamentals and battery command blocks. Aspects of the methodologies from both Winkler et al. (1993) and Hill (1997) were used in the review. The objectives reviewed are contained in the fire support, field artillery, and joint applications (JA) blocks of instruction. Naturally, the FAOAC is organized around individual skills and knowledge, as is the practice with institutional training. Many of the tasks are, however, practiced collectively in operations. Although the Army's improvement plans for training support include matrices that integrate individual and collective tasks, these matrices are not yet complete and available to clarify the task relationships for use in this project. Data were therefore gathered about the collective or individual nature of each task as well as the learning sequence most appropriate for the tasks. The following actions were taken in the task review:

- a. All terminal learning objectives (TLOs) taught in the identified blocks of instruction were assembled in a master task list. The TLOs are described in detail using the existing enabling learning objectives (ELOs);

- b. A content analysis of the TLOs was performed. Bloom's taxonomy (1956) of cognitive learning levels was used to assess the learning tasks. TLOs were assigned to one of the

learning levels based on the level of performance implied by the verbs in the TLO and the ELOs. Appendix B provides a list of the 37 TLOs that were reviewed. Appendix C provides definitions of the cognitive levels used to classify the TLOs.

c. Attributes of the objectives were measured by a survey of instructors in FAOAC to determine instructor opinions of the following:

1. The cognitive level at which the TLO needed to be taught in the FAOAC to prepare the student to enter his or her next job assignment (cognitive level criteria were provided);
2. The criticality of the TLO as a task in prospective job assignments;
3. Whether the TLO was a prerequisite to other TLOs on the list;
4. Whether the TLO would be performed at an individual level of performance and accountability or a collective level;
5. The importance of hands-on experience and interaction with an instructor and peers to provide entry level skill for the next assignment, versus whether the task could be in a DL format before residential training;
6. Whether the TLO was deemed to be ascending as a critical combat task, staying the same, or descending in importance;
7. Whether the task was critical to planning, preparation, or execution in an operational situation.

Respondents were offered a space to re-write the task statement if needed or to add tasks not on the list, which they believed should be included in small group instruction.

d. A subset of the survey items was also administered to all active field artillery battalions.

e. These dimensions were used to categorize the tasks.

Review of Current Methods and Technology

A review of the teaching methods and technology currently in use in the FAOAC POI was conducted. Both traditional classrooms (Level 1) and simulation-based classrooms (Level 4) were included in the review since sections of FAOAC small group instruction take place in both settings. The review involved course rotations 4-97 and 5-97.

Instructors were surveyed regarding the current methods and media used for each of the 37 TLOs in the review. Implementation of the instructional technology was also observed in class sessions. In addition, instructors were asked to specify the method or media they would recommend, if different from that currently used.

Experiment to Assess Current Training Impact

An experiment was conducted to compare the impact of the classroom methods and technology on the learning process and on the performance of students after training between the classrooms with simulation capability and the classrooms without simulation.

A number of studies have been conducted regarding the effects of hypermedia technology on the learning process. (See Reed, 1997, for an overview of this research since 1990.) Generally, classroom hypermedia are categorized as providing “knowledge presentation,” “knowledge representation,” or “knowledge construction.” The FAOAC classroom simulation technology supports knowledge construction in that students are taught to use specific tools including the simulation to guide their construction of products that reflect their understanding of the domain of study.

Studies in hypermedia comparing outcomes for control groups who did not receive an educational treatment with experimental groups receiving the treatment comprised 38% of the 73 studies reviewed by Reed. The number of outcome studies with control groups diminished over time for the period of the studies reviewed. Studies emphasizing the learning process of an experimental group with no control group became more prevalent. The current experiment was designed to combine the two approaches to provide the best overall assessment for the FAOAC. Information was gathered about both the learning process and learning outcomes, and these findings were compared between treatment and control groups.

a. Hypotheses. Many classroom settings and methods can promote group interaction and a deeper level of learning through the promotion of a shared mental model, depending on the instructional intent and expertise of the instructor or facilitator. It is asserted here that the simulation-based classrooms being integrated into Army residential training are an excellent method to actively promote group interaction and “deep learning” through simulation-based practical exercise. Deep learning is defined as integration of knowledge into one’s mental models as problem-solving tools rather than just uninterpreted knowledge familiarization.

1. It was hypothesized that the simulation-based classrooms would stimulate a more satisfactory student-centered, exploratory learning process, which is defined as more student-initiated interaction and more information seeking than in the traditional classroom.

2. Deep learning is promoted by active learner participation and is associated with affective involvement found in collaborative interaction (Biggs, 1987, as reported in Newman, Johnson, Webb, & Cochrane, 1997). Therefore, it was also hypothesized that the students who completed small group training in the simulation-based classrooms would perform better (i.e., demonstrate more knowledge integration during performance) as a simulated staff after training. Better performance was operationalized as better instructor ratings and self-ratings on specific learning tasks in the post-training exercise. Performance was rated in the areas of information exchange and knowledge seeking, accurate and "on task" communication, supporting behavior (correcting team errors and providing assistance), and team initiative, as well as performance of tasks reflecting targeted TLOs.

b. Participants. The participants in the experiment were the students and instructors of the FAOAC. Only those students and instructors who were in cycle during the 4-97 and 5-97 course rotations participated. Students are Army captains or lieutenants (promotable) (P), allied officers, and Marines. The researcher devised the data collection schedule with the FAOAC Branch Chief, based on the occurrence of key simulation-based practical exercises dictated by the POI.

c. Procedures. The independent variable was the presence of the simulation-based classroom activities for the treatment group and no simulation-based activities for the control group within the classroom. (Classrooms without simulation support for practical exercises planning used the simulation only outside the classroom and only to execute plans developed without simulation access in the classroom.) The Janus simulation, as well as the initial fire support automated system (IFSAS) emulators, is currently in common use in the classroom. The technologies were provided and operated by D&SABL at Fort Sill and constituted the usual equipment provided to the automated FAOAC course sections. Students were randomly assigned to a section before training by the USAFAS.

Dependent variables observed during the learning process (practical exercise) were interaction behaviors of the students, exploratory behaviors (information seeking), and student attitudes by administration of a written questionnaire. All dependent measures of the learning process were gathered repeatedly in both settings. Instructors were informed about the observation and the student attitude survey before the experiment began. Instructors were not given a copy of the observation instrument during the experiment so as not to encourage or

discourage behaviors to be observed. Each student was given a survey to be completed after the practical exercise that was observed. All observations were live. No audio or video recordings were made.

Observers were trained in the use of an observational checklist that supported data recording of the following variables during in-class practical exercises:

- The number of times and length of time students consulted the Janus simulation, the IFSAS emulator, or the PC during the targeted practical exercise periods
- The number of times and length of time spent at maps and sketches
- The number of times manuals or other handbooks were consulted
- The number of questions and comments that were exchanged between students
- The total number of questions and comments initiated by the students to the instructor or by the instructor to students

Student surveys were administered immediately after each practical exercise that was observed.

Following the completion of the small group instruction blocks studied here, each course section engaged in a capstone exercise involving the role play of brigade and battalion staffs in a simulated battle. Dependent variables measured after training were indicators of performance as noted in Hypothesis 2. Measures used in after-training performance were instructor ratings of each student group and student ratings of their own group's performance.

Capstone exercises planning was done in the classroom before execution in the Janus simulation facility. During the course of the battle, instructors routinely function as observers who gather data for after-action reviews (AARs) with the students. This experiment introduced a structured observation and rating form to help the instructors capture salient behaviors in categories during the exercise. Those data provided the basis for the instructor to then rate the student groups for the exercise on each variable noted in Hypothesis 2. The form was designed with the instructors before the capstone exercise. Ratings were completed before any discussion of the capstone exercise performance with the students. Students rated the same behaviors after the exercise and before discussion of performance. Students did not gather observations during the exercise.

Grades earned on exams during the course were also gathered for all participating students. The exams included an objective course final and two subjectively graded performance assignments. Analyses were made to compare the learning outcomes between automated and

non-automated classroom settings. Students and instructors were not informed that grades would be used as experimental data during the course.

Data from the various sources were analyzed using qualitative descriptions, descriptive statistics, analyses of variance (ANOVAs), and *t* tests.

Observers were non-participants and were trained to have the minimal impact possible on the lessons to be observed by avoiding unnecessary conversation or movement about the classroom. Instructor forms for use in the capstone exercise were constructed in line with the factors usually observed by instructors to the extent possible to avoid additional work and demotivation on the part of the instructors and thus interference with the capstone exercise.

Method to Devise a Learning Model That Predicts Enhanced Battlefield Performance

Findings from the course analysis were used to produce a technology-by-task matrix to discern the sequence of learning and the type of technology most supportive of the types of tasks to be taught. A review of current practice and theory in instruction was conducted in other military settings, academia, and industry. The review of current theory and practice was used to develop a model for advanced learning and to clarify requirements for technology integration. Recommendations for development or acquisition of supporting methods and media were documented in a technology integration strategy with mid-term and long-term features. The analysis and resulting learning model and technology recommendations of this project are described in the remainder of this report.

FIELD ARTILLERY SCHOOL BATTLE STAFF TRAINING FY 1997: NEW WINE IN OLD BOTTLES

Cognitive Task Analysis

Given the challenge to battle staff performance evidenced by lessons learned and desired future operational capabilities, we must re-engineer the learning process to transfer more skills to the field and to understand how to use technology to support that goal. Re-engineering the learning process requires us to understand that officer advanced training is not like most Army training, and we would not want it to be. To train is to create an expected mode of performance, to create proficiency that meets or exceeds a set standard, to cause someone or something to react predictably during given circumstances. The practice of an art is not wholly predictable. It is based on a firm foundation of techniques, but it goes beyond that foundation in as many

unanticipated ways as there are experts and situations. To be effective, we must address this area of officer training as high level *learning*.

To verify this assumption about the high level of learning required in the Officer Advanced Course, we conducted a cognitive task analysis of the POI, a survey of instructors, and a survey of all active field artillery battalions to analyze the learning objectives. Eleven FAOAC instructors were surveyed, and 104 surveys were sent to units. Seventy-two (69%) of the surveys were completed and returned. There was significant agreement between the field perceptions and the perceptions of the instructors about the learning objectives.

The analysis consisted of a review of the verbs used in each TLO and in the existing ELOs, and an assessment of the products and processes the student must complete to meet the objectives. Appendix C contains definitions of the six levels of learning objectives in the cognitive domain that were used to categorize the 37 TLOs. (See Appendix B for a list of the TLOs.) These cognitive levels were devised by Bloom (1956), and the descriptive material in Appendix C is taken from the U.S. Army Command and General Staff College Author's Handbook for instructors (1988). The six cognitive learning levels, in increasing order of complexity, are knowledge, comprehension, application, analysis, synthesis, and evaluation.

The lowest level of cognitive learning is knowledge—the ability to recall information. Comprehension is the next level and connotes the ability to grasp the meaning of information such as being able to explain what has been learned. The next higher or more complex level is application—the ability to use information, concepts, or principles in a given situation. Analysis is the ability to break the whole into various parts, such as to diagram, to differentiate, or to infer past what was learned. Synthesis is the ability to create a new whole from the parts previously learned by modification, reorganization, or composition. The highest level is evaluation—the ability to infer the value of something, based on what was learned. Evaluation involves interpretation, appraisal, and justification.

Verbs typically used in a learning objective at each level have been cataloged to make the taxonomy more useful for classifying learning objectives (see Appendix C). Using the verb in the learning objective to categorize the objective can be misleading, and the products and processes of the entire learning task must be reviewed to categorize the objective. For example, “develop a plan” fits into the application category in terms of the verb “develop.” However, review of the learning objective could lead the analyst to infer that the act of planning is a synthesis activity when a new plan must be created from various parts through reorganization and composition.

The objective could also be categorized as application if the student only had to prepare existing templates for a plan using given information with little or no reorganization or composition.

Using these cognitive learning levels, the authors classified 37 objectives as stated in the POI into the six categories to assess what level of advanced learning is required of the students. The application level of learning was the most frequently used category. It was assessed that 16% of the TLOs were at the knowledge and comprehension levels. A total of 43% of the TLOs were found to be at the application level. The remaining 40% of the TLOs were found to be at the highest levels of cognitive learning—5% analysis, 16% synthesis, and 19% evaluation. (The second percentage listed on the figure is the classification made by a group of instructors as discussed next.)

Figure 3 shows the 37 listed by their POI designation (such as FS3) and an assigned number 1-37. Each TLO appears under its resulting cognitive level categorization. Each TLO was placed under the cognitive level category it most closely matches. No attempt was made to analyze the priority of the TLOs or the amount of time devoted to them in the course as part of the analysis. Figure 3 also offers a comparison with the instructors' ratings of the cognitive level of the TLOs. Those ratings are described in the section immediately following.

Input from FAOAC Small Group Instructors—Learning Objectives

A survey was administered to all FAOAC instructors immediately before a large rotation of the instructors in June 1997. Eleven surveys were completed. Four instructors had taught four course rotations, two instructors had taught three times, four instructors had taught once, and one had not yet taught. The survey assessed a number of variables that were used to answer two questions: (a) what should be taught and (b) how should it be taught from the instructors' perspective?

The assumption was that only TLOs meeting most of the following criteria should be taught in the residential, small group instruction portion of FAOAC—a relatively expensive type of training. The TLO should be

- At or above the application level (as lower level objectives are more amenable to DL);
- One in which proficiency is desired before field assignments;
- Requiring face-to-face instruction according to the instructor or SMEs;
- Critical to operations;
- Largely collective in execution (to reinforce skill transfer between learning in a group and collective practice in the field).

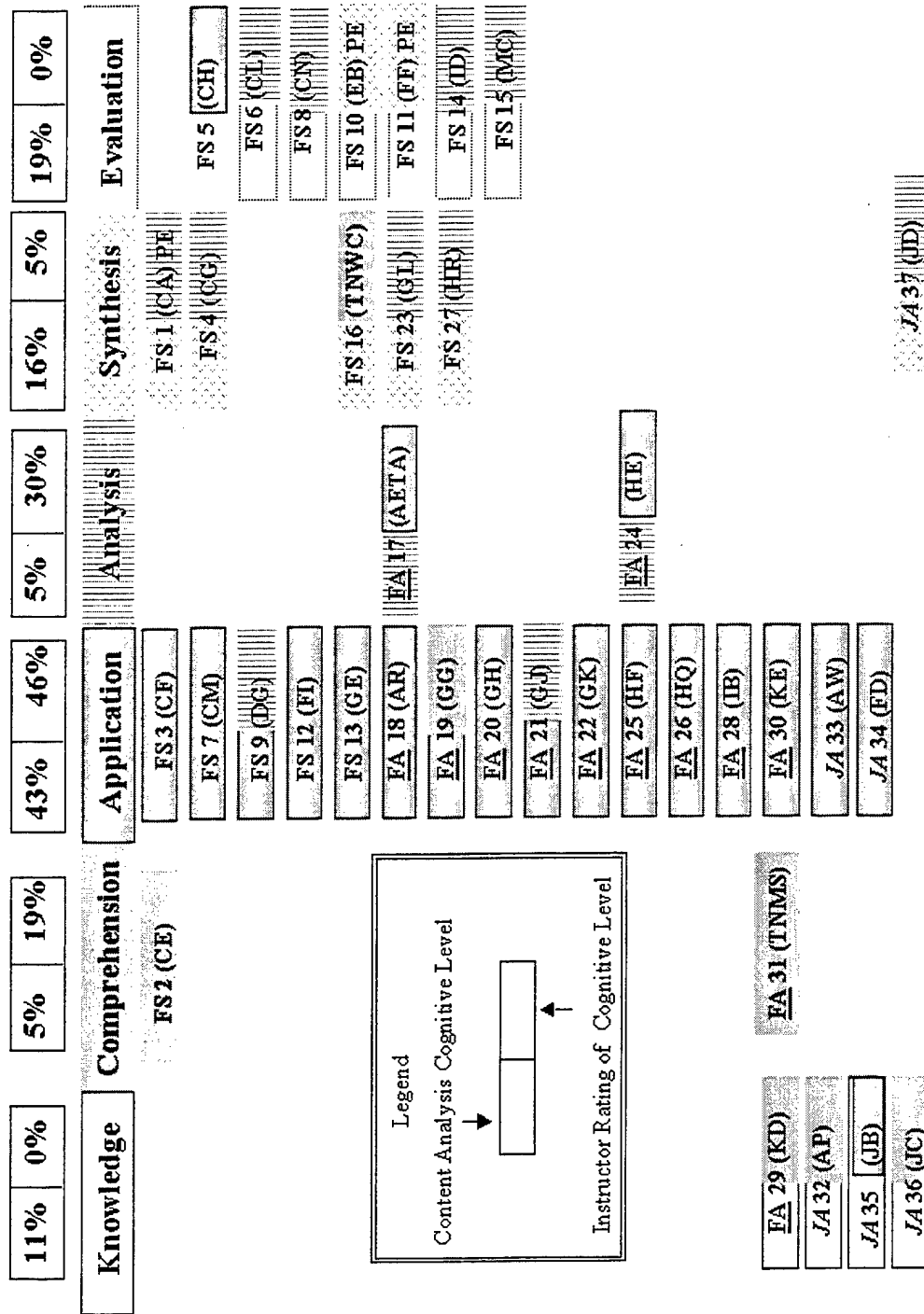


Figure 3. Cognitive level of advanced learning objectives.

Survey results were examined to determine which TLOs met the criteria according to instructors. Which TLOs are taught at the application cognitive level were determined first. (Definitions of the learning levels were provided to the instructors as part of the survey.) To consolidate the instructors' viewpoints of the cognitive learning levels, an average level for each learning objective was derived by assigning a number 1 through 6 to each of the levels and averaging the 11 ratings. The categorizations derived from the instructor survey were then compared to the findings of the content analysis. Figure 3 provides a comparison of the percentage of TLOs in each category according to the task analysis and the percentage in each category as rated by the instructors.

Figure 3 reveals that a large part of the course can be placed at the application level when the POI content analysis and averages of the instructors' survey results are both considered. The content analysis placed 43% and the instructors placed 46% of the objectives at the application level on average. On average, the instructors placed another 35% of the objectives at the analysis and synthesis levels, but none were consistently placed at the evaluation level. The content analysis placed 40% of the TLOs above the application level. Table 1 compares the results of the content analysis with the average ratings of the instructors. Both analyses place a large emphasis on the application cognitive learning level, with a secondary emphasis on the analysis level by the instructors and on synthesis and evaluation by the content analysis.

Table 1

Number of Terminal Learning Objectives Placed in Each Cognitive Learning Level by Content Analysis and by Instructor Survey

	Content analysis	Instructor survey
Knowledge	5	0
Comprehension	2	7
Application	16	17
Analysis	2	11
Synthesis	5	2
Evaluation	7	0

None of the 37 TLOs were rated by the instructors as becoming less critical for performance in operational settings. *Seven TLOs were rated by the instructors as becoming more*

critical in operations because of changing operational commitments, technology, and other modernization issues. The TLOs are

- TLO 4: Develop and rehearse a fire support plan.
- TLO 7: Plan employment of special munitions.
- TLO 13: Advise the commander about employment of combat observation laser teams (COLTs) and fire support teams (FISTs).
- TLO 14: Recommend employment of fire support in offensive operations (opns).
- TLO 21: Perform target value analysis.
- TLO 35: Describe U.S. Army doctrine for support and stability operations.
- TLO 37: Employ light and heavy forces in support and stability operations.

Table 2 indicates which of the TLOs met most of the criteria for remaining in small group residential instruction. Twenty-three of the 37 TLOs (62%) reviewed were candidates for residential training, based on meeting the need for new graduate proficiency, being rated by instructors as needing face-to-face training, and being at the application cognitive level or above. Ratings of collective performance and increases in the criticality of the task in operations are also shown for those 23 TLOs.

All 23 TLOs may not be allowed to remain as part of residential small group instruction as further reductions in residence time are made. These 23 TLOs do, however, warrant special consideration in terms of instructional methods and media. To address this issue, we must identify methods to teach complex, cognitive skills at a distance or create methods to integrate the TLOs so they can be addressed simultaneously in a time-compressed fashion in residence.

The sequence in which the TLOs should be learned was also assessed to support the development of an overall framework for the flow of the course. A set of seven TLOs was identified that support the performance of other TLOs. These seven TLOs form the basis of much of the higher level learning and are thus a prime target for DL instruction before residence or further integration across the POI.

- TLO 3: Apply the top-down fire planning process.
- TLO 4: Develop and rehearse a fire support plan.
- TLO 8: Use the tactical decision-making process to develop and recommend courses of action (COAs) and write an operations plan (OPLAN) or operations order (OPORD).
- TLO 9: Apply the U.S. Army doctrine in defensive operations.
- TLO 18: Develop the field artillery organization for combat.
- TLO 21: Perform target value analysis.
- TLO 22: Produce a field artillery support plan.

Table 2

Twenty-three TLOs Established as Priority for Residential Instruction by Instructor Ratings

TLO (all TLOs at application level or above)	New graduate proficiency critical	Becoming more critical in operations	Needs face-to-face training	Collective
1. Apply troop leading procedures company or team (CO/TM) level	✓		✓	✓
3. Apply top-down fire planning process	✓		✓	
4. Develop and rehearse fire support plan	✓	✓	✓	✓
6. Recommend fire support in heavy defense	✓		✓	✓
8. Write OPORD	✓		✓	✓
9. Apply defensive operations principles	✓		✓	
10. Develop battalion TF OPORD in defense	✓		✓	✓
11. Develop battalion TF OPORD in offense	✓		✓	✓
12. Apply offensive operations principles	✓		✓	
14. Recommend fire support in offensive operations	✓	✓	✓	
15. Given fragmentary order (FRAGO), develop order for movement to contact (MTC)	✓		✓	✓
17. Advise commander about the use of target acquisition (TA) assets	✓		✓	
18. Develop FA organization for combat	✓		✓	
21. Perform target value analysis (TVA)	✓	✓	✓	✓
22. Develop a field artillery support plan (FASP)	✓		✓	✓
23. Develop FASP, FA organization, and TVA for offense	✓		✓	✓
24. Plan employment of FA battalion	✓		✓	
25. Plan logistics for FA battalion	✓		✓	
27. Develop FASP, FA organization, TVA for defense	✓		✓	✓
33. Plan fires for air assault (AASLT) operations	✓		✓	✓
34. Develop fire support plan (FSP) and plan battalion movement for military operations on urban terrain (MOUT)	✓		✓	✓
35. Describe stability and support operations (SASO) doctrine in given context	✓	✓		
37. Employ forces in joint or light scenario	✓	✓	✓	

Instructors were also asked to check all battle phases in which a TLO would be performed as a task in an operational setting. Phase of battle was included because media and methods to support an emphasis on planning skills may differ from those that support preparation or execution skills.

Planning was checked by an average of 10 of the 11 instructors for all 37 TLOs. Preparation was checked by an average of eight instructors for every TLO. Execution was checked by an average of seven instructors for every TLO. While the instructors clearly felt that most of the learning objectives were executed across battle phases, they somewhat emphasized the course objectives occurring in the planning phase of battle.

Input from Active Component Field Artillery Battalions—Learning Objectives

A total of 104 unit surveys was administered. Each FA battalion was asked to designate two staff officers to complete a copy of the survey. A total of 72 surveys was returned and usable for analysis—a 69% return rate.

The survey asked staff officers to assess each of the TLOs in the FAOAC. The TLOs were stated as operational tasks. Assessments requested were in terms of (a) proficiency needed by a new FAOAC graduate, (b) criticality of the task in the current tactical environment, and (c) whether the task is becoming more critical in operations. The findings were compared to the findings of the instructor survey.

Differences between the instructor ratings and the field ratings were as follow. The field rated six TLOs as needing new graduate proficiency in addition to the 23 TLOs agreed upon by both groups (see Table 2).

Of the six TLOs identified by the field as needing new graduate proficiency, which were not also identified by the instructors, none were selected to add to the list of candidates for continued residential instruction or special DL instructional methods. Three of the six were not added to the priority list because they were seen as not needing face-to-face instruction to be taught at the application level. They are

- TLO 20: Prepare a schedule of fires.
- TLO 26: Compute the ammunition required supply rate (RSR)
- TLO 28: Plan a convoy for an FA unit.

The other three of the six TLOs were not added to the priority list since they were rated at the comprehension level TLOs by the instructors, and the field is probably a more appropriate setting for achieving ability level beyond comprehension in these areas.

- TLO 19: Coordinate the operations of division artillery (DIVARTY) and FA brigade operations centers.
- TLO 29: Identify reconnaissance, selection, and occupation of position (RSOP) requirements peculiar to urban terrain, which enhance survivability and sustainability.
- TLO 31: Describe nuclear, biological, and chemical (NBC) in the battery defense.

The instructors had rated seven TLOs as becoming more critical in operations. Table 2 does not show all seven TLOs but only those that also met the other criteria in the table. Only three TLOs were rated as becoming more important by the field respondents on average. All three are already in the list of priority objectives.

- TLO 17: Advise the commander about the employment of target acquisition assets, including fire finder radar, survey, and meteorological data systems.
- TLO 35: Describe U.S. Army doctrine concerning military operations other than war.
- TLO 37: Employ light and heavy forces in support and stability operations.

In summary, there was enough agreement about the TLOs among the instructors and the field to maintain the proposed list of 23 TLOs for special consideration.

Categorization of Objectives Into Learning Stages

Categorization of the objectives was based on the results of the content analysis, the survey of the FAOAC instructors, and the survey of FA battalions who receive new graduates. TLOs were categorized into learning stages, based on these attributes: (a) the cognitive learning level required in the FAOAC, (b) instructor ratings of the need for face-to-face training, (c) the perceived need for new graduate proficiency, (d) whether the corresponding task in the field was becoming more critical to operations, and (e) whether the corresponding task in the field is collective or individual in nature. The purpose of the categorization was to provide a clearer understanding of the types of technology appropriate to the learning and to set the stage for development of a learning model.

First, six learning stages were devised. They are described in Table 3. Technically oriented tasks are viewed as part of the foundation of a knowledge domain, and tasks requiring judgment were considered a part of advanced practice or the art of a domain. (The first and last of the six stages do not apply to FAOAC advanced training.)

Table 3

Six Learning Levels Devised for Military Training of Cognitive Skills

Military Science

1. *Foundation Framework* (not applicable to FAOAC) Sets the stage to enter a domain of knowledge; knowledge and comprehension level only. No real ability to apply knowledge is expected.
2. *Foundation Proficiency* Technical tasks are learned at the application level. The TLOs do not need face-to-face training unless there is a physical performance component of the objective that cannot be simulated or described. Teamwork can be taught and reinforced by means of drills. Little or no judgment is required.

Military Art

3. *Advanced Framework* Sets the stage for the student to move from technical tasks to the art of a knowledge domain. Tasks are learned at the comprehension level in this stage, which will later be learned at the application and analysis levels and above in the advanced proficiency stage.
 4. *Advanced Proficiency* Training for tasks that can be performed competently by an intermediate level practitioner in a knowledge domain at the application and analysis levels and occasionally above. When collective performance is required, it is based on a complex application of team skills. Requires sustained exploration in an authentic setting to work through this extended period of learning how to apply principles across settings to achieve proficiency. Judgment is required.
 5. *Expert Framework* Sets the stage for the skilled intermediate practitioner to begin to practice a higher level of proficiency. Emphasis is on adding information at the comprehension level to expand an already rich understanding of a knowledge domain.
 6. *Expert Proficiency* (not applicable to FAOAC) Training and practice of tasks performed at the highest level of proficiency in a field at the analysis, synthesis, and evaluation levels. Requires authentic practice during demanding conditions.
-

The 37 TLOs representing the art of fire support were categorized into this structure of learning stages. Figure 4 graphically conveys the categorization into stages of the TLOs by one of their five empirically determined attributes.

1. *Foundation Framework*. No objectives reviewed in this project are at this level. The fundamentals block of instruction of small group instruction could be viewed as fitting into this

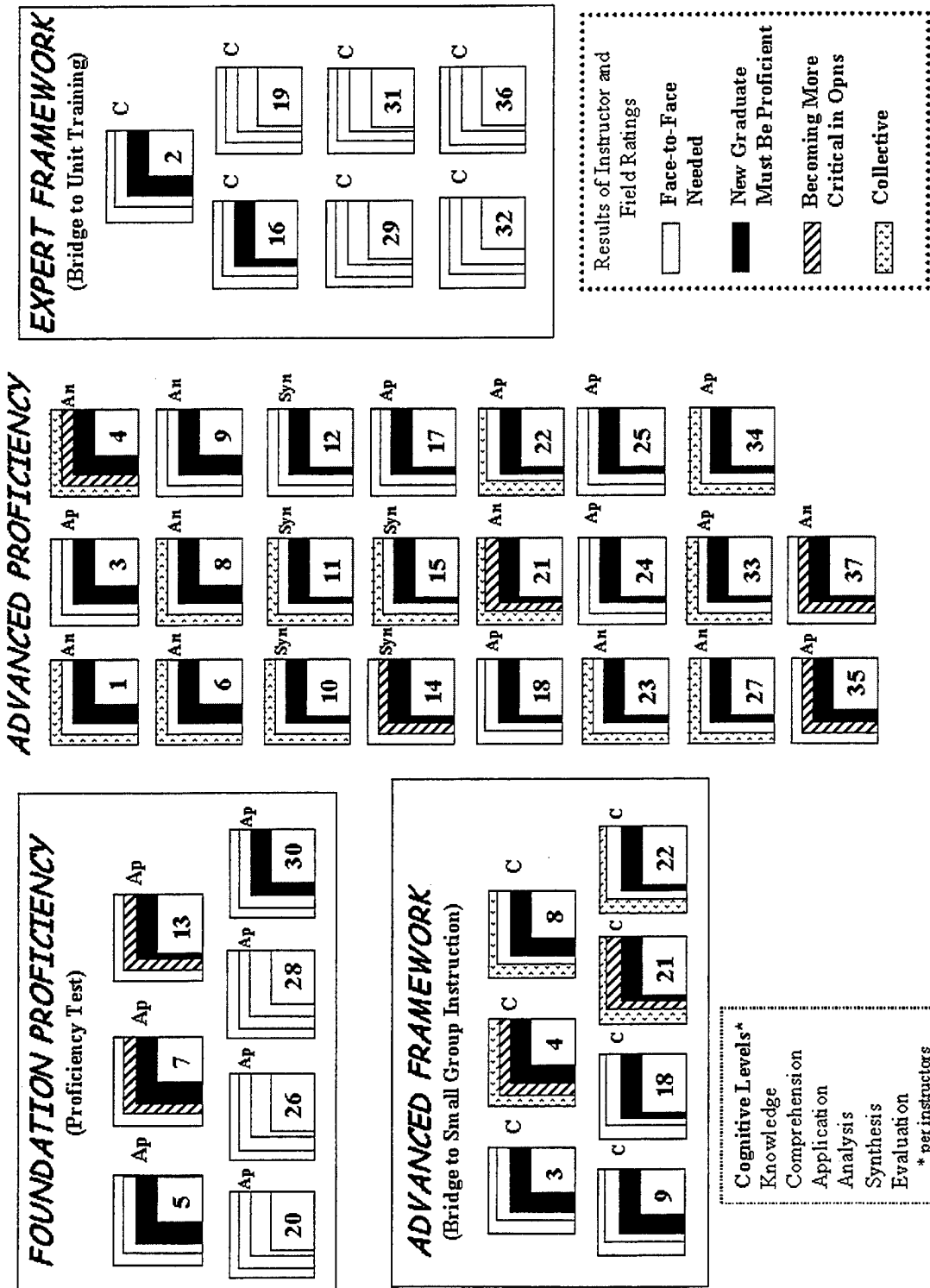


Figure 4. Categorization and sequence of learning objectives.

category and as an immediate candidate for conversion to a self-study, DL format. An exam should be required. Students could attempt to pass a test to skip this portion. Material should be available to the students in the residential phase for self-initiated review as needed.

2. **Foundation Proficiency.** Seven TLOs were identified that need to be learned at the application level, are somewhat technical in nature, and do not need face-to-face instruction. This material should be converted to some self-study format and be available for pre-residence study. A qualifying exam should be conducted before residential instruction. Material should be available to the students in the residential phase for self-initiated review as needed.

3. **Advanced Framework.** Another group of TLOs easily converted to pre-residence study was identified in the analysis. Seven key TLOs among the 23 designated as advanced proficiency seem to constitute advanced framework tasks when taught only at the comprehension level. The seven TLOs form the basis for many of the advanced proficiency tasks according to the instructors' perceptions of course sequence. It is suggested here that during pre-residence preparation, the student be exposed to these seven TLOs to at least the comprehension level to allow the student to begin to develop a cognitive framework for advanced proficiency. Such preparation would ensure that intense, time-compressed residential training would be maximized as students would be ready to engage in a higher level of learning when they arrived. Material to continue reinforcement of basic terminology and concepts associated with these seven TLOs would also be available through technology-based instruction for self-study during the residential portion of the FAOAC to correct any specific areas not comprehended in pre-residence study. These seven TLOs are repeated in the next block of instruction but are taught at higher cognitive levels.

4. **Advanced Proficiency.** Advanced proficiency instruction would be conducted during residential, small group instruction. The instruction would be comprised of the 23 TLOs for which face-to-face instruction, proficiency for new graduates, and instruction at or above the application level are required. Thirteen of the TLOs also are primarily collective in operational execution and would be enhanced by student group interaction. Any attempt to export all or most of these TLOs in a DL format would have to be carefully monitored, and innovative methods for DL must be developed. If taught in DL fashion, these TLOs in this phase of learning require guidance and mentoring from an experienced instructor with whom the student can interact in some way following self-study.

5. **Expert Framework.** The expert framework category consists of tasks that are somewhat technical in nature but broad in scope. The TLOs are believed to be information most

likely to be reinforced and trained at a higher cognitive level later, during unit training. The TLOs do not require face-to-face instruction, are not collective in nature, and are currently taught at the comprehension level. A group of seven TLOs was selected as fitting this category and being amenable to self-study during the course or immediately after (if administratively feasible). It is recommended that the TLOs be covered immediately before the next assignment as possible.

6. *Expert Proficiency.* Although students are not expected to achieve this level during FAOAC, there needs to be a plan to introduce informed observation of expert practice into the course.

The current battery command block (not reviewed here) consists of a set of administrative tasks outside the art of fire support. These TLOs should also be made available for self-study, and an exam should also be required. As noted before, only the advanced proficiency portion of learning should *ideally* be conducted in residence. If this is not possible, innovative instructional methods must be designed to export these TLOs via DL and to reinforce the TLOs in an integrated efficient manner during an ensuing, condensed residential session. How to conduct instruction at the advanced proficiency stage became the focus of this project.

Methods and Technology, Fiscal Year 1997


Instructors were surveyed regarding the methods and technology (educational media) currently used in FAOAC. The survey required that the respondent specify both the medium and the method used to instruct each TLO. The survey form provided the respondent with a list of methods and media for reference but did not restrict the responses to that list. Respondents were also asked to provide their recommendations for changes in course media and methods. Four experienced instructors responded to the survey.

Findings are organized in terms of three blocks of FAOAC TLOs identified in the task categorization scheme discussed previously: advanced proficiency, foundation proficiency, and expert framework. The advanced framework level is subsumed under advanced proficiency for the analysis of this survey since these TLOs are not currently taught separately from the TLOs categorized as advanced proficiency.

Table 4 provides an overview of how the instructional media and methods are currently used. The TLO analysis revealed that the most cognitively complex block of instruction would be advanced proficiency if the TLOs were categorized as suggested. The instructors used the highest number of different media and methods to teach this group of TLOs. Foundation proficiency

TLOs would be at the next lowest cognitive level of instruction (application only). Instructors used the second highest number of different media and methods for this block. The expert framework TLOs are taught at the comprehension level only and currently use the smallest variety of different methods and media. *The results indicate that instructors are currently using more varied combinations of methods and media to teach more complex sets of tasks.*

Table 4
Number of Different Types of Media and Methods Currently
Used to Instruct Three Learning Objective Categories

	<div style="text-align: center;"> Most to least cognitively complex instruction  </div>		
	Advanced framework or advanced proficiency	Foundation proficiency	Expert framework
Average number of methods used	7.91	4.86	4.57
Average number of media used	5.87	4.14	3.14

For purposes of this analysis, the methods were grouped into two categories: instructor-centered methods and student-centered methods. The three groups of TLOs were examined for emphasis on student-centered learning. Media were not divided into these two categories since any media can be used in either way, depending on the method employed.

Table 5 shows the distribution of instructor-centered versus student-centered learning methods across the three categories of learning tasks. *The instructors use the widest variety of methods and media to teach the most cognitively complex learning tasks (advanced proficiency), including a wide variety of student-centered methods.* The instructors use instructor-centered methods for a great percentage of the TLOs in the cognitively complex block, although the paradigm for innovation in Army training is based on moving to a student-centered teaching model. The current reliance on instructor-centered instruction for these TLOs could be an effort to enforce accountability in this key area, or it could reflect the instructors' need to introduce the advanced framework in this area and proceed to advanced proficiency within the same course.

Table 5

Proportion of Instructor-centered Versus Student-centered Instructional
Methods Used Across Three Learning Objective Categories

Method	Most to least cognitively complex instruction →		
	Advanced framework or advanced proficiency 23 TLOs	Foundation proficiency seven TLOs	Expert framework seven TLOs
Percentage of TLOs using the method			
Instructor-centered			
Lecture or presentation	100	100	57
Demonstration	78	29	14
Examination	48	0	0
Outside lecture	22	0	14
Student-centered			
Discussion	100	100	100
Student presentation	96	100	100
Reading	87	57	29
Practical exercise	87	57	43
Writing	57	0	29
Role play	52	0	29
Student demonstration	30	43	0
Field exercise	22	0	14
Terrain walk	9	0	14
Field trip	4	0	14

Two classrooms were used for FAOAC, which contained simulation capabilities, IFSAS emulators, and a range of media including large screen projection of computer-generated graphics presentation (see Figure 5). The media supported

- quick slide development,
- easy integration of video clips and full length video into instruction,
- access to the internet for research, and

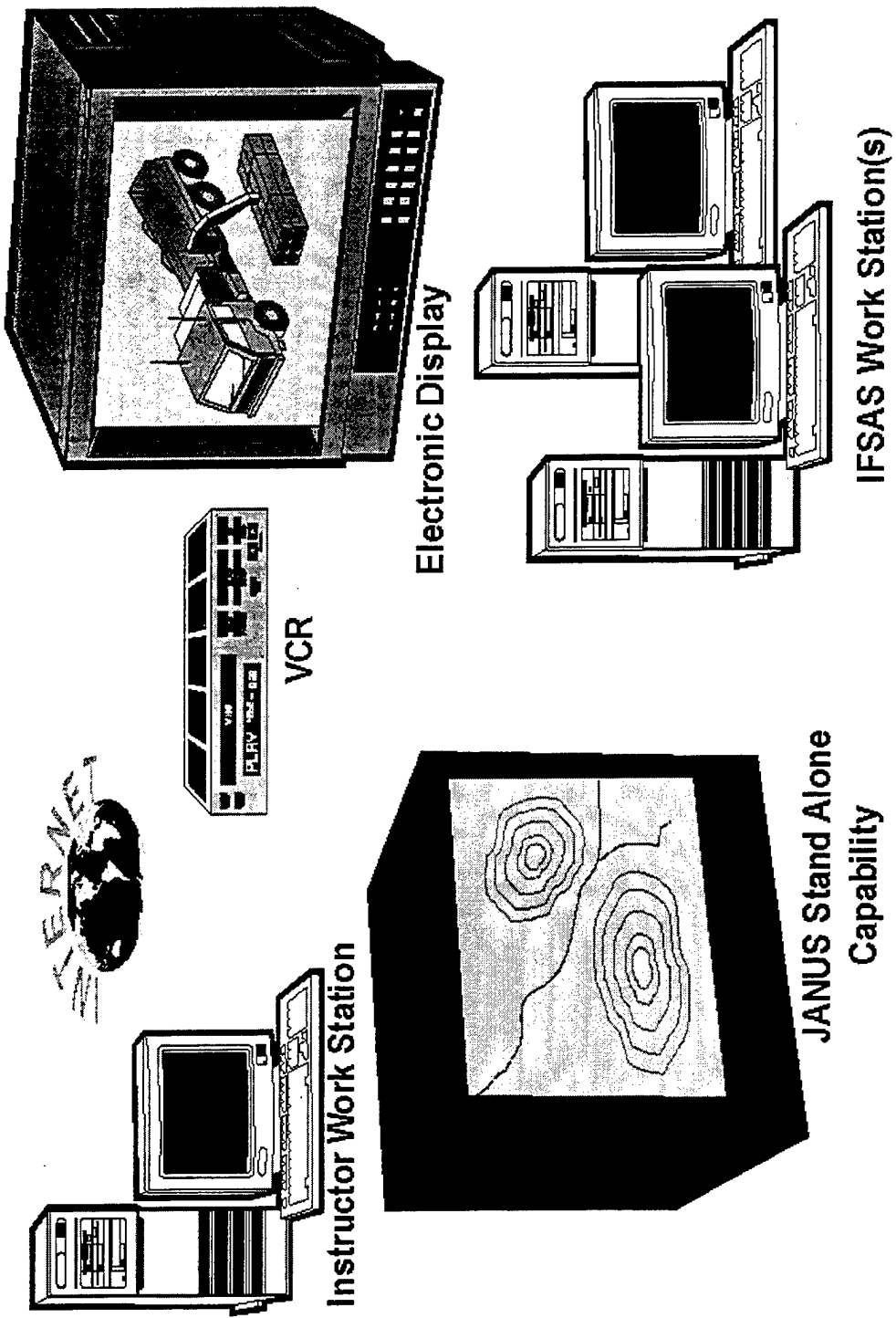



Figure 5. Experimental classroom capabilities in fiscal year 1997.

- access to an application called “Microderm” for analysis using computer-generated map displays on a PC platform.

Despite the range of media available, traditional media still dominated the instruction; computer-generated slide presentations were the only new technology consistently used. The simulation and IFSAS in two classrooms directly support only three (13%) of the 37 TLOs in FAOAC small group instruction (see Table 6).

Table 6

Media Used to Support Instruction in the Three Learning Objective Categories

	Most to least cognitively complex instruction 					
	Advanced framework or advanced proficiency 23 TLOs		Foundation proficiency seven TLOs		Expert framework seven TLOs	
Media	Number of TLOs supported and percentage of TLOs (in parentheses)					
Computer slides	23	(100)	7	(100)	7	(100)
White board	22	(96)	6	(85)	4	(57)
Books, manuals, handouts	20	(87)	6	(85)	3	(43)
Maps, overlays	20	(87)	2	(29)	2	(96)
Sand table	12	(52)	2	(29)	0	(0)
Internet	9	(39)	0	(0)	1	(14)
Transparencies	8	(35)	0	(0)	1	(14)
Workbooks, charts, tables	6	(26)	3	(43)	0	(0)
Video	5	(22)	3	(43)	2	(96)
Janus simulation and IFSAS (with no outside links)	3	(13)	0	(0)	0	(0)
Other physical models	3	(13)	0	(0)	0	(0)
Non-automated self-made displays	4	(17)	0	(0)	2	(96)
Compact disk	0	(0)	0	(0)	0	(0)
Video disk	0	(0)	0	(0)	0	(0)
Programmed instruction	0	(0)	0	(0)	0	(0)

Instructors were also asked what methods and media they would like to use if resources were available. Desired changes in methods and media are summarized in Table 7 and are organized by the three categories previously used. Arrows indicate an increase or decrease is desired overall in the number of methods or media. Generally, the instructors would like to see fewer methods used and more media in all the areas of instruction. The larger number of media desired generally resulted from a request to add CD-based lessons, other self-study formats, DL, a virtual tactical operations center (TOC) environment, and large screen map displays in addition to what is already available.

The most complex area of instruction, advanced proficiency, is recommended in this report for residential, small group instruction. In that area, methods desired were lectures to cover most of the TLOs in combination with student reading and participation in practical exercises. Supporting media recommended were some self-study materials including CD, but predominantly, the instructors would like to use computer slides, large screen terrain display, the Janus simulation (on campus links only), maps and overlays, with some use of a virtual TOC and teleconference to execute this portion of the course. DL was seen to apply to only four of these 23 objectives.

In the foundation proficiency area, 100% of the TLOs were viewed as amenable to CD-based study or some other type of self-study. Also, 100% of the TLOs were seen as appropriate for DL. Lecture, reading, discussion, and practical exercise were seen as methods of choice. These elements could be incorporated into a distance format. Janus practical exercises were also seen as useful to support most TLOs in this area. *Therefore, some element of practical exercise should be incorporated into exported training in this area even if the TLOs are exported for DL.*

In the expert framework area, most (five) of the seven TLOs were seen as amenable to DL by the instructors. Janus simulation practical exercises were seen as less appropriate. CD-based study, reading, and lecture were the methods and media preferred to support this area of study.

When asked what else should be done to improve the media and methods for FAOAC, one instructor responded that teleconferencing capability needed to be available in the classroom, and links need to be made with Armor and Infantry Officer Advanced Courses. Publications for students in a CD format instead of paper manuals are desired. Although student multimedia workstations are described in the Classroom XXI Master Plan (TRADOC, 1996b), one instructor noted a preference for all students to be issued laptop computers. (This preference was also strongly stated at the 1997 Tactics Directors' Conference held in October at Fort Leavenworth.)

Table 7

Media and Methods FAOAC Instructors Would Like to Use

Most to least cognitively complex instruction →			
	Advanced framework or advanced proficiency 23 TLOs	Foundation proficiency seven TLOs	Expert framework seven TLOs
Average number of methods desired	3.13 ↓ ^a	4.86	4.29 ↓
Average number of media desired	6.87 ↑	5.43 ↑	4.00 ↑
Methods desired	Percentage of TLOs needing the method or medium According to one or more instructors		
Instructor-centered			
Lecture or presentation	91	100	100
Demonstration	0	14	0
Examination	4	57	43
Student-centered			
Practical exercise	96	86	57
Reading	83	86	86
Discussion	26	86	71
Terrain walk	9	0	29
Role play	4	57	57
Media desired	Percentage of TLOs needing the method or medium According to one or more instructors		
Computer slides	96	57	57
Large screen terrain display	91	0	0
Janus simulation (on campus)	83	86	43
Maps, overlays	74	29	43
Virtual TOC	57	0	14
Compact disk	52	100	86
Teleconference	48	0	14
Programmed instruction or other computer-based instruction or self-study	26	71	29
Video disk	17	57	0
Distance learning	17	100	71
Simulation linked off campus	13	0	0
Books, manuals, handouts	9	14	29
Sand table	9	0	0
Workbooks, charts, tables	0	1	0
Video	9	14	14
Other physical models	4	0	0
Non-automated, self-made displays	4	0	0

^aRepresents an increase or decrease as compared to baseline in Table 4.

Less time in student-taught classes is desired. This is reflected in comments by one instructor and in the fact that no instructors recommended student presentations as a method for any TLO. Instructors felt that data gathering about media and methods suggestions should be an ongoing process. This process could be implemented by distribution of a methods and media survey during each course rotation for instructors to make notes as the TLOs were taught. Generally, the perception is that a number of TLOs need to be converted to some form of self-study and exported for DL so that there is more time in residence for executing simulation-based practical exercises for the remaining TLOs.

Measuring the Impact of Technology in the Classroom

A field experiment was conducted to compare the learning process and outcomes in advanced fire support training during two conditions: simulation-based classrooms and non-simulation-based classrooms. It was hypothesized that while small group instruction in general may produce a satisfactory learning process and outcomes, the simulation-based classroom would better support the process and outcomes. Desired elements include (a) a student-centered, exploratory learning process, (b) greater satisfaction with the learning process, and (c) better training outcomes, that is, more transfer of learning to an exercise outside the classroom after training. Findings were examined to determine whether the simulation-based classroom as currently implemented is supporting the evolution to better the learning process and outcomes and to help refine recommendations for further innovation.

To test for differences in the learning process, student interactions and exploratory behavior were observed, and students and instructors were surveyed about the learning process. To test for differences in training outcomes, students and instructors were surveyed about specific aspects of student performance in a post-training exercise, and course exam grades were collected across the two conditions.

Learning Process

The instructional setting in which the learning process was assessed was the classroom practical exercise. Students in both the simulation-based classroom and the non-simulation classroom completed the same practical exercises. The practical exercise is the only portion of small group instruction that uses the simulation in class. Both conditions afford an opportunity to maximize collaboration and to explore concepts with reference materials during group problem solving.

Deep learning is hypothesized in the literature to occur when students are engaged in active participation with affective involvement. Student interaction and exploration were observed as indicators of active participation and involvement. Interaction behavior was defined as student to student, student to instructor, or instructor to student-initiated questions or comments. Exploratory behavior was assessed by observing the number of times and variety of materials consulted during problem solving.

Total numbers of student behaviors as observed in various categories were used to make comparisons. Totals in the observation categories were reduced to percentages of total interactions observed. Because a total number of observations for each group rather than individual scores were compared, a comparison of means (such as an ANOVA or *t*-test) was not appropriate. To test for differences between proportions of types of behaviors in the two conditions, a Z-value was calculated for the different interaction behaviors across the two situations.

a. Student-Initiated Interaction Behavior. In the simulation supported classrooms, a total of 2,664 verbal interaction behaviors were observed, and 3,094 interactions were observed in the non-simulation classrooms over the two conditions. There were 24 students in each condition. Both conditions produced a high rate of student-initiated interaction behavior. Ninety percent of the interactions in the simulation classroom were student initiated as compared to 89% of the interactions in the non-simulation classroom. The proportion represents the total number of student-initiated interactions in a condition divided by the total number of interactions in the condition. It had been hypothesized that the simulation-based classroom would facilitate a higher level of student-initiated interaction during the practical exercise. Calculation of a Z-value confirmed that the *proportion of student-initiated* interactions in the simulation-based classrooms was statistically equal to the proportion found in the regular, non-simulation-based classrooms. The findings across treatment conditions are summarized in Table 8.

b. Student Exploratory Behavior. In each classroom, there were manuals, maps, and sketches, and at least one computer available for student access. In the simulation-supported classrooms, students had additional computer terminals to consult (Janus computer terminals and IFSAS emulators) during the practical exercise. It was hypothesized that the simulation-supported classrooms would encourage more exploratory behavior, that is, use of resources.

In the simulation-supported classrooms, students explored reference sources a total of 133 times during the observation period, and 139 observations were made of students exploring reference sources in the non-simulation classrooms. The non-simulation classrooms

were observed for 10 minutes longer than the simulation classrooms. The number of exploratory behaviors was 0.24 reference per minute in the simulation-based classrooms and 0.25 per minute in the non-simulation classrooms. A Z-test revealed no difference between the two conditions in terms of exploring reference sources.

Table 8
Student Interaction Rates and Proportions of Student-Initiated Behaviors During Two Conditions

	Simulation classrooms	Non-simulation classrooms
Total number of interactions	2664	3094
Total minutes observed	550	515
Number of interactions per minute	4.84	6.01
Rate of student-initiated interactions	2397	2752
Percentage of student-initiated interactions ^a	90%	89%

^aNo significant difference in the proportion of interactions across the two conditions.

To assess the nature of the exploratory behavior, the proportions of the type of references consulted were also compared. No hypothesis had been made about the nature of the exploratory behavior. The students in the simulation-based classrooms consulted a computer 17% of the time when a resource was consulted. Students in the non-simulation classrooms consulted a computer 11% of the time when resources were consulted. The simulation-based classrooms had the same computer as the non-simulation-based classrooms plus two additional types of computers as noted previously, represented by four or more additional terminals. Calculation of a Z-value indicated that the proportion of computer use in simulation-based classrooms was not significantly different than that of students in the regular classroom conditions. Therefore, students in the simulation classrooms where three types of computer resources were available during the practical exercise did not consult a computer a significantly greater proportion of the time than did students without the additional computer resources.

The students in the simulation-based classrooms consulted maps or sketches during the practical exercise 49% of the time when a resource was consulted, and the students in the non-simulation classrooms consulted maps or sketches 63% of the time. Calculation of a Z-value found that there was no difference between the students in two types of classrooms in the proportion of times maps and sketches were consulted during the practical exercises.

The students in the simulation-based classrooms consulted manuals during the practical exercise 35% of the time when a resource was consulted, and the students in the non-simulation classrooms consulted manuals 26% of the time. Calculation of a Z-value indicates that the students in the simulation-based classroom did not use manuals significantly more during the practical exercises as a proportion of the resources they consulted. The findings across treatment situations are summarized in Table 9.

Table 9
Student Exploratory Behavior

	Simulation classrooms	Non-simulation classrooms
Total number of times reference material consulted	133	139
Total minutes observed	550	560
Number of reference consultations per minute ^a	.24	.25
Number of times (percent) computer consulted ^a	22 (17)	15 (11)
Number of times (percent) maps and sketches consulted	65 (49)	88 (63)
Number of times (percent) manuals consulted	46 (35)	36 (26)

^aNo significant difference in the level of exploratory behavior or in the nature of resources consulted during the practical exercises.

c. Student Perceptions of the Learning Process. To further assess the learning process, all students in each condition were surveyed about the learning experience. An 11-item survey was used. Each item was answered using a five-point Likert scale from 1 (strongly agree) to 5 (strongly disagree). The data are summarized in Table 10. Questions 1, 2, 3, 6, 7, 8, 9, and 10 were designed to assess whether students perceived elements of a student-centered, effective process. Items 4, 5, and 11 were designed to assess whether the students felt immersed in the

learning situation. Because the items were not designed to constitute a scale with a single score, a two-tailed *t* test was conducted to compare each item across conditions.

Table 10
Findings From Survey of Student Perceptions of the Learning Process

Item	Average score per item		<i>t</i>
	Simulation	Non-simulation	
Effectiveness Items			
1. This practical exercise allowed me to look at operations from several perspectives.	1.72	1.46	1.46 NS
2. This practical exercise helped me remember what I had previously learned and apply it when needed.	1.97	1.50	2.78 ^a
3. During the practical exercise, I was an active participant rather than a passive observer.	1.57	1.55	-0.09NS
6. I felt like the practical exercise prepared me to learn more about this area of operations in the future.	2.10	1.57	2.57 ^a
7. The instructor supported and reinforced learning during the practical exercise.	1.66	1.57	0.45NS
8. I increased my feelings of competence about this training material as a result of the practical exercise.	2.00	1.68	1.35NS
9. The practical exercise stimulated student interaction.	1.69	1.36	1.88NS
10. The practical exercise stimulated students to seek and use information.	1.79	1.39	2.31 ^a
Immersion Items			
4. The practical exercise was often boring.	3.41	4.04	-2.41 ^a
5. I often felt like I didn't know what I was supposed to be doing during the practical exercise.	3.51	3.96	-1.67NS
11. Too much time was wasted in the practical exercise process.	3.45	4.21	-2.73 ^a

^a*p* < .05 (1 = strongly agree; 5 = strongly disagree)

It was hypothesized that the simulation-based classrooms would have more of the effective, student-centered elements of instruction during the practical exercises. Students in both situations agreed that they perceived various elements of a constructivist learning environment as defined in the survey (items 1, 2, 3, 6, 7, 8, 9). The structure of small group instruction during the practical exercises is obviously supportive of the constructivist instructional paradigm to some degree with or without simulations.

Average student ratings across both conditions were positive, falling between “strongly agree” and “agree” on all the items:

- (Item 1) allowed them to see operations from several perspectives,
- (Item 2) helped them to remember what they had learned when they needed to apply it,
- (Item 3) stimulated active participation,
- (Item 6) prepared them to learn more in the future,
- (Item 7) that the instructor supported learning during the exercises,
- (Item 8) the exercises increased their feelings of competence,
- (Item 9) stimulated student interaction, and
- (Item 10) stimulated them to seek and use information.

Although students in both conditions reported positive perceptions regarding the effectiveness of the exercises, there was a statistically significant difference between the two settings about how strongly each group agreed with three of the eight “effectiveness” items. The results of *t*-tests comparing the items across the two conditions showed a statistically significant difference in items 2, 6, and 10. *Every significant difference was in the opposite direction from that hypothesized.* Non-simulation classroom students more strongly agreed about item 2 that the exercises helped them to remember what they had learned when they needed to apply it ($t [55] = 2.78; p < .05$). They more strongly agreed about item 6 that the exercises prepared them to learn more about that area of operations in the future ($t [55] = 2.57; p < .05$). They more strongly agreed about item 10 that the exercises stimulated them to seek and use information ($t [55] = 2.31; p < .05$).

It was hypothesized that the learning process in the simulation-based classrooms would stimulate more of a feeling of immersion in the learning experience for the students. Items 4, 5, and 11 were designed to assess the perception of being immersed in the exercise. *Two of the three items were significantly different across groups, but again, they were in the opposite direction than was hypothesized,* with the non-simulation classroom students disagreeing more strongly that the exercise

- (Item 4) was often boring ($t [55] = -2.41; p < .05$), and
- (Item 11) wasted too much time ($t [55] = -2.73; p < .01$)

In addition to 11 opinion items on a five-point scale, the students were provided an opportunity to make comments about the learning process. These comments included a positive finding for the use of one group within the classroom. Two students felt that the work was more easily divided into battlefield operating systems, and the work within each system could be divided among students for collaboration on a more detailed final product and better learning experience when one large group was used. Another student in the simulation classroom felt that the students worked well together to prepare a detailed offensive plan.

Students also felt that the offensive (initial) practical exercise should be slower or more time should be allotted for analyzing the problem or for “walking” through a prescribed process with the instructor’s help. In the simulation-based classroom, too much time was spent explaining how to use Janus and what will work and not work in Janus. One student did not feel that enough guidance was given in general and that collaboration was not effective because brighter students did more work and learned more. Only these few students were given the opportunity to brief the instructors about work group efforts, which helped these students learn more than others. Guidance should be given as analyses are made and products developed instead of at the end of large segments of work. The operations order was seen as not dynamic enough. In the defensive exercise, two students felt that the exercise was too diffuse over time and was therefore tedious. Three students felt that the availability of a large number of key roles because of two staffs being formed in their classroom was crucial in letting lots of students have learning opportunities during the exercises.

d. Summary of Findings Regarding the Learning Process. It was hypothesized that the learning process during the practical exercises in the simulation-based classrooms would (a) be more student centered, more immersive, more collaborative; (b) stimulate more student exploratory behaviors and recall of material learned before the practical exercise; (c) increase feelings of competence; and (d) prepare students to augment current learning with future learning experiences.

Findings for the measures of process used here did not support this hypothesis in any aspect. There was no statistically significant difference in the level of student interactions (collaborative behavior) across the two settings. There was no difference in the level of student-initiated interactions (student-centered behavior) across the two settings. Both settings had a high level of interactions and student-initiated verbal interactions. There was no difference in the

number of consultations of reference materials of all types (exploratory, information-seeking behavior) across the two settings. There was no difference in the types of reference materials used across the two settings, despite there being a greater number of computer terminals and types of terminals available in the simulation-based classrooms.

The students themselves, as reflected in survey results, perceived statistically significant differences in the learning process across the two learning settings on seven survey items, but *all* differences were in the opposite direction from that hypothesized. Students in both educational settings were positive about the learning process as measured by the survey. However, the students in the non-simulation classrooms were more positive about the learning experience. They more strongly perceived that the practical exercises helped them to remember and apply knowledge, prepared them to learn more in the future, stimulated student interaction, stimulated students to seek and use information, and that the exercise was not boring, did not leave them not knowing what to do, and did not waste time. Subjective verbal reports from the students and instructors indicated that the technology in the classroom was difficult to use and may have contributed to slightly less positive learning experiences in the technology-based setting.

One student pointed out that no prior training was given in Janus use for the students, and time was wasted in learning how to use it and discussing what was and was not possible in the Janus simulation (as opposed to what was possible on the battlefield). Some students commented about a high level of collaboration in their group, which resulted in good learning and detailed student products. Others felt that only a few students truly benefited from the exercises, did most of the work, and gave the feedback to the instructor at the end of the work assignment. A lack of coaching by the instructor was indicated by one student who felt that the work was done in chunks that were too large before feedback was exchanged with the instructor. Comments indicated a need to structure practical exercises so that all students understood the process they were to follow at the beginning, especially for the first practical exercise. Such comments led to the conclusion that both the learning process (such as the facilitation role of the instructor) and the role of technology in the classroom need to be addressed to improve the practical exercises.

Overall, the presence of simulation technology in the classroom appeared not to support an evolution toward student-centered, exploratory, more satisfactory learning experiences, over and above what is already achieved through the small group instruction process.

There is some evidence that the technology may have even mildly detracted from the learning experience.

Learning Outcomes

It was hypothesized that the learning processes would be different across the two conditions, and therefore, the learning outcomes would be different. However, the only differences in the learning process across settings were in the opposite direction from that hypothesized, that is, the non-simulation classroom processes were more satisfactory. The outcome variables were examined to look for differences in learning outcomes, but no links between process and outcome were explored. Three types of measures were used. The first was a structured observation scale for the instructors to rate the post-training performance of their student group in several dimensions. The students were then also asked to rate their group's performance. Regular course examination scores across the two conditions were also compared.

a. Instructor Ratings of Post-Training Exercise Performance. Instructors were asked to observe and rate their student group's performance during the final capstone exercise for the course that is conducted after all the tactical training is complete. Students were rated on four group process behaviors (supporting behavior, information exchange, communication, and staff initiative) and performance of seven TLOs that the instructors had indicated were the key objectives addressed in the capstone exercise. Definitions of the group process behaviors were provided to the instructors.

There were four instructors—two from simulation-based classrooms and two from non-simulation classrooms. Two of four instructors rated all 11 items for their group. One instructor responded to only seven of the items, while another instructor responded to only nine of the items. *Ratings were from 1 (poor) to 5 (very good)*. Across items, the overall average ratings given by each instructor were 4.45, 3.89, 4.05, and 2.40. Comparison by *t* tests indicated that the differences found were not along the lines of simulation versus non-simulation classroom instructors. There was a significant difference in ratings between the two non-simulation instructors ($t [15] = 5.14; p < .001$) and between the two simulation classroom instructors ($t [18] = 2.25; p < .05$).

The instructors were also asked to relate their *observations about performance in the different staff process areas*. In terms of providing backup and assistance, one instructor noted that his students were reluctant to seek support or backup if it meant walking from room to room to discuss problem areas, but two other instructors noted that good performance in this

area compensated for initial weaknesses in the plan or clarified understanding. The average rating of this item across the four instructors was 4.33. Regarding information exchange, one instructor noted that students did not exploit the internet or IFSAS capabilities. Two other instructors noted good information seeking, although questions asked were not always answered. The average rating of this item was 3.83. Overall communication performance was impaired by poor communication network simulation or information support by Janus operators. Overall rating was 3.50. Staff initiative was seen as “above average,” but one instructor felt that student input was ignored. Overall rating was 4.00 (of a possible 5) (“very good”).

The instructors were also asked to relate their *observations about how the students executed the tasks in relation to the applicable TLOs*. The first TLO (item 5) was “apply the top-down fire planning process.” Performance of this process was not viewed positively by the instructors. (Note that this process has consistently been a key area needing improvement, as cited in the military lessons learned literature.) The overall rating was 3.00, the lowest of any performance items. Comments included that all resources were not used to plot and attack enemy positions, the initial plan was vague, and execution of the resulting plan was mediocre.

The second TLO (item 6) was “develop and rehearse a fire support plan.” The overall rating was 3.75. Rehearsal did not point out some weaknesses in the plan. The third TLO (item 7) was “apply the tactical decision-making process to develop and recommend COAs and write the operations plan and operations order.” The rating average across the instructors was 4.38. Battalion performance was good, but one instructor noted that brigade performance was weaker. The fourth TLO (item 8) was “apply the U.S. Army’s operations doctrine in offensive operations.” The ratings across this item averaged 3.63. The fifth TLO (item 9), “recommend the employment of fire support in offensive operations,” was rated 4.13. The sixth TLO (item 10), “develop a field artillery support plan and conduct target value analysis,” was rated 4.50. The seventh TLO (item 11), “plan fires to support air assault (AASLT) operations, including an artillery AASLT,” was rated 4.50. Instructor ratings of all performance items are shown in Table 11.

In summary, the weakest of 11 student performance areas across groups as rated by the instructors were application of the top-down fire planning process (3.00); communication (3.50), which was negatively impacted by the simulation of network capabilities in the exercise; application of offensive doctrine principles (3.63); rehearsal of the fire support plan (3.75); and information exchange (3.83). Differences in ratings across groups depended on the instructor, not the type of classroom in which he or she taught.

Table 11

Performance Ratings by Instructors in Capstone Exercise

Performance item	Rating across groups
Providing backup and assistance across the team (supporting behavior)	4.33
Information exchange	2.83
Clear, complete communication	3.50
Staff initiative	4.00
Apply the top-down fire planning process	3.50
Develop and rehearse fire support plan	3.75
Apply tactical decision-making process	4.38
Apply offensive operations principles	3.63
Recommend fire support in offensive operations	4.13
Develop field artillery support plan and conduct target value analysis	4.50
Plan fires to support an air assault operation	4.50

1 = poor; 5 = very good; ratings differences depended on instructor, not treatment setting

b. Student Ratings of Post-Training Exercise Performance. Students in each group were asked to rate the same performance items for their group as the instructors had rated. Students were not made aware of the performance items before the exercise ended and did not discuss their performance with instructors before completing the rating forms.

An ANOVA revealed no difference between the student groups' overall ratings of their performance in the final exercise either as a factor of the type of classroom or the instructor. The students rated themselves, across groups, lowest in

- item 4 (3.38) staff initiative,
- item 5 (3.70) "apply the top-down fire planning process,"
- item 6 (3.58) "develop and rehearse a fire support plan,"
- item 7 (3.28) "apply the tactical decision-making process to develop and recommend COAs and write OPLAN or OPORD,"

- item 8 (3.33) “apply the U.S. Army’s operations doctrine in offensive operations,” and
- item 10 (3.52) “develop a field artillery support plan and conduct target value analysis.”

c. Course Examination Grades. A comparison was made of the measures used by the instructors to judge the students (the examination grades) across the two conditions. Three examination grades per student were available for the four sections in the experiment. Tests 1 and 2 are products that are subjectively graded for quality by the instructor. Test 1 pertains to the fundamentals and fire support blocks of instruction and Test 2 to the field artillery block. Test 3 is a comprehensive, multiple choice examination over all blocks of instruction. There were no significant differences among the three test scores across the two conditions (see Table 12).

Table 12

Summary of Course Examination Grades by Treatment Condition

	Test 1	Test 2	Test 3	Average
Simulation classrooms	87.87	88.94	86.96	87.92
Non-simulation classrooms	85.09	89.68	88.22	87.72

d. Summary of Findings Regarding the Learning Outcomes. It was hypothesized that there would be a difference in performance in the final exercise between the performance ratings for students who had been trained in the simulation-based classroom and those who had not. No evidence was found for this hypothesis. The only statistically significant difference found in learning outcomes was in the ratings among the four instructors. The differences were not along the lines of the hypothesis and merely showed a significant difference in the way each individual instructor rated his or her group. While this may be a problem with the rating scale or measures chosen, it does not seem likely, since the four student sections showed no statistically significant differences among their ratings, using the same scale. A lack of difference in outcome measures is consistent with a lack of marked difference in the learning process between the simulation and non-simulation classrooms.

The Technology Gap in Today's Training

Technology as currently implemented is not improving training. What is proposed here is a framework that relates type of training to type of technology to first identify the types of technology needed in advanced military training. *The proposed training framework for use in matching training with technology and methods consists of three dimensions. The first is the stage of learning.* Three learning stages are used to represent a progression from novice to intermediate to expert. The stages are foundation, advanced, and expert. Within each stage, there is an introductory or framework period and a period of proficiency. In the framework period, terminology, technical procedures such as computation methods, and a cognitive structure suitable to the level of training are introduced. In the proficiency period, the student is able to perform tasks, meeting the standard and using proper terminology and procedures (see Table 3).

The second dimension is the training context--individual, small group or collective. The third dimension is the method or medium most appropriate to a learning stage, given the training setting. The training framework is illustrated in Figure 6. Proper placement of existing learning objectives within the learning stage and training setting will form an intersection with the most appropriate methods or media types.

The framework is constructed on the following assumptions. The first is that military tasks are well structured at the foundation stage of training and ill structured at the expert stage. Second, the advanced stage is a crucial transitional stage. *The advanced stage is probably the longest learning stage in a number of skill areas and forms a bridge from novice to expert learning. Many learners find this stage difficult to negotiate.* Much exploration, practice, and feedback are needed to ensure that prior successful training at the foundation level is not a negative factor in advanced performance as the domain becomes more ill structured.

The soldier is a practitioner at the advanced proficiency stage and begins another transition to the expert learning stage when he or she enters unit training. To maximize unit training resources and the individual's transition toward expert performance, the soldier and the small group must be supported with job aids and self-development materials, just as they were when moving from foundational learning to advanced learning.

For a soldier to enter the advanced framework level, foundational proficiency must be generally secure. A basic concept of the domain has been formed by the learner, and basic procedures can be reliably performed, usually under direction. Currently, media and methods available in fire support are primarily appropriate for the foundational level and then represent a

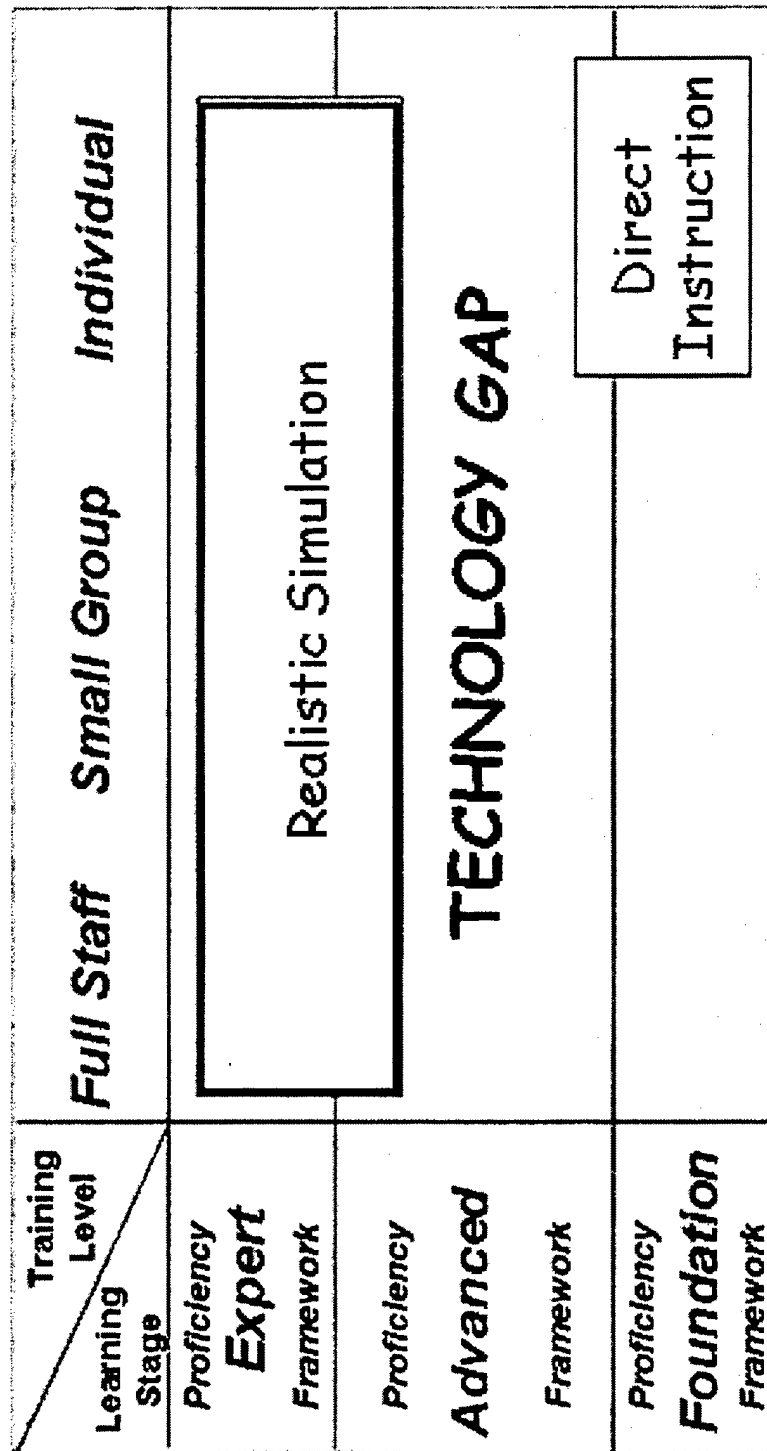


Figure 6. Illustration of the technology gap for advanced training.

plunge almost directly into an exercise in a realistic simulation of complex battle space without enough practice to make the exercise beneficial (see Figure 6).

Our conclusion was that while most instructional materials available are appropriate for the knowledge and comprehension levels, higher levels of learning and practice are supported by instructor-developed practical exercises before a simulation is used for the three targeted TLOs. No technology-based products are available to support higher level cognitive skills acquisition other than a full-scale, realistic simulation. Simulation-based training can rapidly take a student into and past the application cognitive level. Instructors cited the difficulties associated with students playing roles in a realistic simulation of staff members with which they were not familiar. Students often made elementary mistakes in assumptions or biases in applying knowledge in simulation-based training.

While this type of behavior is not surprising, it led to the conclusion that some type of preparatory training should be designed for implementation before the expensive use of realistic simulation which is fairly resource intensive. Training and multimedia production in the Army are geared to knowledge and comprehension learning products because most Army training is procedural or technical. In addition, training products at the higher cognitive levels are resource intensive to construct. As a result, students and trainees are often put directly into simulation-driven exercises with only knowledge and comprehension level training as a precursor.

The technology matrix can be linked to the cognitive levels of training as shown in Figure 7. Identifying the cognitive levels at each intersection of training and learning level further enables us to match a given course to a level of technology. Figure 8 matches the FAOAC TLOs by cognitive level to the matrix. Seven of the TLOs are repeated in the matrix. These TLOs are taught once at the advanced framework level and again at the advanced proficiency level according to the review of the POI and survey of instructors. Figures 6 and 8 demonstrate that the arena of advanced training is under-supported by technology until the student is well into advanced learning.

To further develop our understanding of the technology and methods that are needed to support cognitive skills training, we consulted the literature to develop a learning model to support this framework.

<div> <div>Training Level</div> <div>Learning Stage</div> </div>	<i>Full Staff</i>	<i>Small Group</i>	<i>Individual</i>
	<div> <div>← Analysis, Synthesis and Evaluation →</div> <div>← Comprehension →</div> </div>	<div> <div>← Analysis, Synthesis and Evaluation →</div> <div>← Comprehension →</div> </div>	<div> <div>← Analysis, Synthesis and Evaluation →</div> <div>← Comprehension →</div> </div>
<div> <div>Proficiency</div> <div>Advanced</div> <div>Framework</div> </div>	<div> <div>← Application, Analysis and Synthesis →</div> <div>← Comprehension →</div> </div>	<div> <div>← Application, Analysis and Synthesis →</div> <div>← Comprehension →</div> </div>	<div> <div>← Application, Analysis and Synthesis →</div> <div>← Comprehension →</div> </div>
<div> <div>Proficiency</div> <div>Foundation</div> <div>Framework</div> </div>	<div> <div>← Application</div> <div>← Knowledge and Comprehension →</div> </div>	<div> <div>← Application</div> <div>← Knowledge and Comprehension →</div> </div>	<div> <div>← Application</div> <div>← Knowledge and Comprehension →</div> </div>

Figure 7. Integration of matrix and currently used cognitive learning levels.

<div> <div>Training Level</div> <div>Learning Stage</div> </div>	<i>Full Staff</i>	<i>Small Group</i>	<i>Individual</i>
<i>Proficiency Expert Framework</i>			2,16,19,29,31,32,36
<i>Proficiency Advanced Framework</i>	3,4,8,1,10,11,27,34,37 3,4,8	22,15,23,24 22	9,18,21,6,12,14,17,25,33 9,18,21
<i>Proficiency Foundation Framework</i>			5,7,13,20,26,28,30

Figure 8. Thirty-seven FAOAC TLOs in small group instruction placed within the matrix.

A LEARNING MODEL TO GUIDE BATTLE STAFF TRAINING REVITALIZATION

A clearer understanding of the types of technology needed was developed in the previous section. The use of that technology must be further defined in terms of an understanding of the learning process to be supported. It is asserted here that the foundation of training re-engineering is not the technology, as stated in the Army Distance Learning Plan (ADLP) (TRADOC, 1996a, p. 2-11), but an underlying learning model to support an implementation strategy. Our proposal "...contrasts with an *ad hoc* approach to design in which features of technology-based learning environments...are based primarily on the affordances¹ of a particular technological medium..." (Jacobson, 1994, p. 142). Affordances typically considered are, for example, (a) primarily that the technology is available, and (b) the technology (rather than a specified learning model) is believed to provide certain benefits.

Current technology and theory in instruction were reviewed to enable us to choose or formulate a model to support the development of a clearer understanding of the technology and methods that are most appropriate for advanced training. The value of instructional theory is in its ability to predict how well instructional designs will meet the desired training criteria. Although learning and instructional theories abound, they are not, however, consistently linked with instructional design in the field and empirically tested. Learning theorists and instructional designers generally lack familiarity with each other's work (Duffy & Jonassen, 1992, preface, p. ix). Although this assessment may be a bit harsh, it indicates a possible gap in the field of education and training. Bednar, Cunningham, Duffy and Perry (1992) make a similar point when they indicate that instructional design draws upon theory but does so in such an eclectic manner as to dilute the substance of any one of the theories in practice. Because of the possibly loose ties in the field between instructional theory and practice, it is especially important that our acceptance here of an instructional theory be clearly linked to its ability to support a learning model that informs instructional design and generates technology assessment hypotheses.

The abundance of theories available easily lend themselves to an eclectic approach by the instructional designer. A method of choosing an instructional theory, based on the assessed training needs, would help to overcome the dilution of theories since too many are combined or the over-reliance on one approach. The following selection criteria were developed to limit the scope of the literature review. The criteria are meant to define the Army's training re-engineering vision and encompass the results of this project's task review. The theory, resulting learning model, and any recommended technology must support

¹what the technology can provide

- the higher level cognitive nature of advanced officer training,
- efficient learning in a time-compressed, residential setting,
- maximum transfer of knowledge to post-graduate assignments,
- the need for some but not all training tasks to be learned in a collective manner,
- student-centered learning,
- the growing emphasis on pre-course preparation and current heterogeneity of incoming FAOAC students, and
- appropriate exploitation of advances in technology.

The sections below contain a review of

- current methods and technology used in other services, academia, and industry,
- the current theories and learning model used by the U.S. Army,
- an alternate theory for advanced training from the literature (i.e., constructivism), and
- the presentation of the learning model and technological recommendations developed for this project, based on constructivist theory.

Technology and Methods Used or Developed in the Military, Academia, and Industry

This section examines approaches and instructional tools in the military, academia, and industry to support advanced military training. Given the lack of available, appropriate training tools for advanced learning, development of experimental courseware is considered as an option. Therefore, the role of the SME or instructor in the construction of products is also considered.

Training initiatives at the U.S. Army Armor School were examined to analyze their training approach and instructional tools. The Armor Officer Advanced Course (AOAC) is probably the closest equivalent to the current experimental, instructional setting of FAOAC. Additionally, because the FAOAC is interested in collaborating with the AOAC as a means of facilitating battlefield synchronization, advances in AOAC are of particular interest.

The AOAC has benefited from the presence of the Force XXI Training Program at Fort Knox, Kentucky. The Force XXI Training Program has combined a number of existing efforts and completed work to begin development of a single training program for the total Army. Investments have been made primarily to provide comparable training between reserve units and active units. There has been an emphasis on DL, but all skill levels (individual, small group, and full staff) are being addressed (Force XXI Training Program, 1998).

The first component of the Force XXI Training Program is training management tools. The second component is a broad array of training support packages (TSPs) to support units in the field. Structured brigade staff exercises have been undergoing development to determine the best method of producing complex training support packages for 16 staff positions at the brigade

level: The brigade or battalion simulation (BBS) is used to support these efforts, which are commonly referred to as the combined arms operations at brigade level realistically achieved through simulation (COBRAS). Brigade staff vignettes that do not involve the use of simulations and are aimed at small group training within the full staff are also undergoing development. Exercises are structured to ensure that the task targeted for exercise is taught.

The current Force XXI TSPs are developed around three missions: movement to contact, deliberate attack, and defense in sector for maneuver forces using the NTC terrain database. Plans are to expand the TSPs to include all combat, combat support, and combat service support units found in a heavy brigade; a fourth mission (stability and support operations [SASO]) will be added. Ensuing packages are planned to provide exercise of the same missions in varying geographical locations that will vary the challenges to the staff.

The third Force XXI training component is training aids, devices, simulators, and simulations (TADSS). Two specific tools are listed in the Force XXI Training Program literature. The individual level training tool is the Battle Staff Training System (BSTS). This tool has been completed. Review of this tool revealed a behavioral orientation of the training and an inflexibility in its structure. Much information is contained in this multi-volume paper-based and compact disk read-only memory (CD-ROM)-based tool. An inability to freely access that information is a limitation imposed by the rigid sequence that a student must follow to work his or her way through training. Individual tasks for individual staff officers are supported for the brigade commander, the battalion commander, 14 brigade staff officer positions, and 14 battalion staff officer positions. Although this tool is very directive in design, ARL and the FAOAC have decided to obtain the complete training package to investigate where it may supplement current training. The tool may be useful in preparing students to role play or in giving them an understanding of multiple perspectives on the battlefield.

The Staff Group Trainer (SGT) is the second specific tool being developed. The tool is not yet available for evaluation but is applicable to advanced training at USAFAS. The training is designed to train groups of staff officers to operate as a team once they are proficient in their individual staff skills. A small group could consist of, for example, the S2, S3, FSO, and engineer to work on the team skills associated with the development of a fire plan.

Three other products that were identified at Fort Knox are of interest. The first is the U.S. Army Military Decision-Making Process (MDMP) tutorial. This tutorial offers a pattern for the administration of distance instruction for complex, advanced training. This subject was specifically selected from the AOAC in order to demonstrate a DL solution for a complex

subject. The solution is a hybrid product that combines CD-ROM technology with on-line asynchronous information exchange between students and instructors. It is not possible to evaluate this product easily, since one must be enrolled in the course with an Armor School instructor to proceed through the lessons.

The MDMP is a mixture of military science and art. Computer-based instruction addresses the science, and feedback from the instructor addresses the art. Small groups of students can collaboratively use a menu-driven system to learn the four phases of MDMP: mission analysis, COA development, COA analysis, and COA decision. Reference materials are easily accessed through the tutorial. A map drawing tool (MapEdit) is embedded in the tutorial to enable students to create COA sketches on a background map. Distance students install the CD-ROM course on their PC, and student products are automatically transferred to the instructor using internet file transfer protocol (FTP) and e-mail.

Students provide the rationale for their answers to create reflection in the learning process and to allow instructors to give detailed feedback. An 8-hour test assesses the students' knowledge and is used to compare with a test of the knowledge obtained by students in non-automated course sections. The hybrid nature of the tool and the use of instructor contact in an asynchronous manner provide a good example for structuring advanced training for distance delivery.

The next product is the Mission Analysis Tutor. This course is more elementary and is completely contained on the internet. The student must be authorized by the Armor School, that is, he or she must have a password. A tutorial following the 11 steps of mission analysis is presented, embedded in a scenario complete with orders, maps, overlays, synchronization matrix, and other resources.

A diagnostic test of 50 items is given and graded on line. No feedback other than a score is provided. Graphic design limitations include a less-than-optimal choice of color schemes and the use of a serif font that is difficult to read. Positive features include the use of paired examples to enhance transfer of learning within the tutorial and tips from experts embedded in various lessons.

A virtual TOC is available within the tutorial to create a context for the mission analysis tasks. SuperScape® supports the presentation of the virtual TOC on line. The TOC allows access to the various reference materials about the context but adds little to setting the context. There is no equipment that must be operated, and all information can be accessed without

“walking around” the TOC. This tutorial can be classified as an “advanced framework individual” tool using this project’s previously presented categorization scheme.

The last product obtained from Fort Knox is a draft report from the Force XXI Training Program, which reviewed instructional development trends related to cognitive task training. Although the report is not yet complete and cannot be quoted, it describes a number of instructional development efforts in the Air Force, Navy, and Marines, which are of interest. *The report also indicates an emphasis on current needs to assess and choose software tools to support courseware development by including a large listing and assessment of commercially available courseware authoring tools.*

Ensuing military research and development efforts cited in the draft document was disappointing. The only tool found at the advanced learning stage which had been completed was the Guidance for Understanding Instructional Design Expertise (GUIDE) software. GUIDE is written for Windows™ and was designed to assist the expert or novice courseware developer with implementing constructivist principles of instruction. Assistance for the SME or part-time courseware developer is a significant trend within the military and industry, and GUIDE was the only completed tool discovered that was aimed at advanced training or higher cognitive level tasks.

The GUIDE software had been sold from Armstrong Laboratories to the Cyber Learning Corporation. GUIDE was obtained for review in this project. Although the concept was attractive, the product was not seen as useful to support development. The product appears to be a pre-Beta version with large segments missing, and some files are complete but would not function. The SME as training developer is a role that continues to grow, and efforts to develop a tool or suite of tools to support this role are required.

Another CD-ROM tool identified was the Tactical Decision-Making Marine Course produced by the Oak Ridge National Laboratories, Tennessee, to replace 44 hours of instructor-led instruction. Although not directly useful in the FAOAC, the CD is a good example of a deliberate effort to design interactive courseware to implement the emerging cognitive learning principles. Although the principles are transparent to the user, their implementation creates a smoother presentation and more learner control than is seen in many products. The demonstration CD was provided to Warfighting and Integration Development Directorate (WIDD) of USAFAS. A number of copies were made and distributed to the courseware developers there. Developers at WIDD were given the course by their supervisor, who believed they should review it as an excellent example of how interactive courseware (ICW) should look. A seminar about the design

principles underlying the development would further support WIDD in moving into this level of courseware development as opposed to simply converting courses from paper to CD.

Other methods and media of interest to instructors and undergoing development in the military fall into the overlapping areas of virtual TOCs and battlefield visualization. The concept of a virtual operations center appeals to instructors because they would like to immerse the students in an operational environment for sustained exploration during the residential phase of training. A virtual environment exists at lower levels such as is seen at Fort Knox in their simulation network (SIMNET) facility. The current plans are to expand the environment in coordination with the NTC development of the modular semi-automated forces (ModSAF) within their synthetic theater of war (STOW). With the maturity of ModSAF and reconfigurable simulators, the Force XXI Training Program plans to expand to brigade level exercises driven by the BBS in this virtual environment. It is envisioned that during a staff exercise, the command group could direct the battle from their vantage point within this expanded virtual world.

The STOW environment at Fort Sill, Oklahoma, has made advances in providing a virtual environment for brigade-level exercises to support the D&SABL Crusader and other experiments. Advances include the ability to interact with a Janus simulated battlefield through tactical equipment. This advance is not ready for direct import into the classroom without some dedicated technical support and alignment of further simulation enhancement in the experimental classrooms with instructional strategies. The need for alignment with instructional strategy was seen as a lesson learned in the Classroom XXI at Fort Leavenworth's Command and General Staff College. The Advanced Learning Environment (ALE) tool was imported into that environment. Because of some dissatisfaction with the ALE, the Battlefield Planning and Visualization (BPV) tool was later added to the classroom. Verbal reports from Leavenworth indicated that a better understanding of current instructional goals and strategies before the new technologies were implemented would have made for better planning. A lack of understanding of current and future instructional goals leads to a lack of understanding of the future obligations that will be incurred to bring technology in line with the instructional needs (such as additional terrain or display capabilities not originally anticipated). Both the ALE and the BPV have already been identified as tools that will be imported into USAFAS within FY 1998. These planning and visualization capabilities are to be provided for use by the FAOAC.

Academic and industrial instructional methods and media were also reviewed during this project. Web-based and PC-based simulations capable of running on personal computers are increasing in the training arena. Such simulations are often used for procedural training at this

time, but advances in web-based and PC-based simulation technology as well as in artificial intelligence are making such simulation technology more supportive of advanced training. Such simulations may make an ideal solution for enhancing some aspects of individual or small group DL or residential learning when they mature to the level where the instructor and student users can manage the software without assistance, but the simulations seem limited in terms of integrating tactical equipment interfaces. The use of PC-based simulations will create a less costly alternative for the development of simulation-based courseware in the near future but is not available for import into the classroom at this time.

Other technologies that were reviewed from the military, industry, and academia are software tutorials to fill the gaps in foundational skills or to introduce concepts in advanced training, collaborative software or courseware, software to support the SME as developer, and software to streamline multimedia development. The students coming to FAOAC are diverse in their preparation. Provision of pre-course individual study material must be coupled with the availability of that material on site to supplement residential instruction. One example was found of a simple tutorial useful to FAOAC students. Fort Leavenworth, Kansas, had developed a CD-ROM tutorial about map graphics and military symbology.

The tutorial is flexible in terms of accessing information, but it does not create a high level of student immersion, and it does not contain electronic versions of pertinent manuals. It is not highly sophisticated in graphics display. Despite any shortcomings, the tutorial was seen as valuable by the FAOAC instructors and students, particularly for allied students. The lack of such tutorials seems to represent a real need. Ideas from students and instructors should be accessed before any pre-course DL tutorials are developed. An experiment could be conducted with new products being tested on a portion of students before widespread distribution is made.

Collaborative software is becoming pervasive in industry and academia. Collaborative courseware built around these technologies is only beginning to emerge. An example of collaborative courseware was found in Anderson Consulting, Inc., internal training. Anderson provides management consultants, who have a high degree of education and experience, to customers around the world. Any training provided to Anderson consultants is therefore on a very advanced level. At the June 1997, Association for the Advancement of Computing in Education World Conference, a collaborative course for distance students was demonstrated. The course was an excellent example of distance collaboration with asynchronous instructor feedback.

Because the courseware is proprietary, it could not be obtained as a model for the development of advanced Army training; it could only be demonstrated at the conference. The

course linked a student group of consultants on the job in locations around the world. No students were in face-to-face contact with each other or the instructor. All students were working on a project that they were responsible for bringing into the course as their personal "authentic" setting. The students were examining their live case study with the help of the instructor and other students using an approved consulting process as their template. The procedures specified, products specified, pitfalls, and advice from experts about each step of the procedure were available to students. E-mail questions and feedback were available to be shared with the instructor and among the students. The courseware served as a type of job aid as well as "just-in-time" training.

No other courseware was identified at this advanced level of instruction which implemented an alternate instructional approach for advanced learning so well. Other uses of collaborative software were found in residential education settings such as on campus at a university, in distance courses, and in ongoing professional discussions on the internet. Microsoft NetMeeting® and Lotus Notes™ were both seen in use. Although Microsoft NetMeeting® is widely available at the USAFAS, no uses of it were discovered during this review. Simply making collaborative software available does not seem to have an impact. Collaborative work or instruction needs to be designed and demonstrated to encourage the use of these technologies.

Technology to support the role of SME as developer was examined. (For a complete review of software, see Appendix D.) In order to respond to shorter development cycles, fewer resources in general, and the need for experimentation to determine development directions, there is a growing trend to blend the SME and developer roles. The technology to do so is not yet developed to the point where a SME can comfortably develop courseware without much training in the software. Support for that process is given in such products as GUIDE and in commercial products such as ToolBook Assistant™. To facilitate the role of the SME in developing courseware, it is still necessary to customize software support. The current version of ToolBook II Instructor™ (version 6.0) includes a software development kit for the advanced user that allows him or her to import the ToolBook Assistant and develop a customized development environment for whatever SME they are supporting. This effort is a blended approach of using commercially available software or customizing software to meet specific requirements. However, it is important to note that one week of intensive training with the professional version of ToolBook II Instructor™ can provide even inexperienced computer users with the proficiency needed to develop relatively polished products, given that they have the time to devote to development.

Pre-design tools, such as Designer's Edge™, help professional and novice developers to plan courseware requirements before actually starting their design. Designer's Edge™, which has been adopted as a standard by the Army, can also be customized and can be linked to ToolBook Instructor™ and ToolBook Assistant.

Digital Trainer® and Microsoft PowerPoint® software both represent probably the simplest and most cost-effective tools for SMEs at USAFAS to develop courseware or presentations at this time. The ability of the SME to directly represent his or her expertise in multimedia will provide a drastic reduction in development time. Digital Trainer provides the SME with a "canned" approach to courseware preparation, which gives a consistent look and feel to training. For the advanced user, the application is too limited since it cannot be customized. For the SME, it may represent an advance in capturing expertise and in presenting it more effectively than a slide presentation. While developers have doubts about the SME as courseware developer, this role is already continuing and will doubtlessly continue to grow.

PowerPoint®, although originally conceived of as a linear, text presentation medium, is actually capable of a wide range of customization to link video, audio, photographs, hyperlinks for random access throughout a file, hyperlinks to other files, and hyperlinks to internet sites, and it is exportable to the internet or CD. PowerPoint® was not designed as a courseware authoring tool, and it does not have training support features such as tracing the student's usage or progress. It is, however, widely available and much more powerful in its most recent version. This power is tremendously underused when it only supports linear presentations. PowerPoint® is a viable tool for capturing and displaying expertise in a manner that is interactive for the student.

Technology already available at USAFAS, such as PowerPoint®, is underused for a number of reasons, including a lack of focused experimentation, a lack of technological support, a lack of time to learn new software, a lack of models, and impediments caused by various users in related work groups having different software and hardware available.

One technology that is not in evidence at USAFAS is emerging software that is designed to drastically cut the development cycle. This software is coming into use in industry, such as the Integreator software. Storyboarding and other steps have been eliminated or collapsed in the new processes. New processes are being presented at training conferences that accelerate production. Given the need for rapid evolution of ICW at this time, an investment to obtain and study these new processes would be advised.

Current Theory Supporting U.S. Army Training

A plethora of instructional or learning theories is available for application in training development. For example, the Theory Into Practice Database (Kearsley, 1994) was developed to make learning and instructional theory more accessible to educators. Summaries of 50 theories are available and are organized in the database by learning domains and by author. One domain is military training. Kearsley proposes that theories of adult learning (such as Knowles, 1984) be considered to support military training, given the experiential learning emphasis, and that social learning theories (such as Bandura, 1977, and Vygotsky, 1978) are important because of the extensive interpersonal interaction involved in much of military, team-based performance.

Knowles' theory of andragogy (adult learning) emphasizes the adult need for self-direction and responsibility for decisions. Assumptions of the theory are that adults need to know why they need to learn something, they need experiential learning, they approach learning as problem solving, and they learn best when the topic is of immediate value.

The social learning theory of Bandura emphasizes the importance of observing and modeling the behaviors, attitudes, and emotional reactions of others. Work based on Bandura's theories emphasizes cognitive models of behavior interacting with the modeling of that behavior in specific environments. Vygotsky's work was mainly done in the context of language learning in children. His theory attempts to explain consciousness as the end product of socialization, and this general theory of cognitive development has become one of the underpinnings of situated learning, which is discussed later in this report.

Kearsley (1994) also asserts that because military tasks are usually well-defined, theories of instruction such as Gagné and Briggs (1979), Gagné (1987), or Merrill (1994) are particularly relevant, and "[t]he criterion-referenced approach of Mager and Pipe (1976) which emphasizes mastery learning is especially salient" (p. 68).

The works of Gagné and Briggs and of Mager and Pipe have indeed formed much of the basis for the military's prescribed Instructional Systems Design (ISD). Gagné's work stipulated that several different types of learning should be matched with different types of instruction. His five major categories of learning are verbal information, intellectual skills, cognitive strategies, motor skills, and attitudes. Types of instruction include problem solving to learn and practice cognitive strategies, exposure to role models and their arguments for attitudinal learning, and a hierarchical approach to intellectual skill acquisition. While Gagné's theoretical framework covers all aspects of learning, he has concentrated on intellectual skills (Gagné & Driscoll, 1988).

Mager's criterion-referenced instruction (CRI) framework incorporates ideas from Gagné's work (task hierarchies, learning objectives) and is supportive of learner control in terms of self-paced learning. CRI requires the identification of tasks, the establishment of a performance criterion, evaluation based on the criterion, and the development of sequential learning modules (Mager, 1975).

Cognitive psychology has been seen in the assessment of Army performance (primarily command and control and team performance) and in the development of computer-assisted performance (such as Smith-Jentsch, Johnston, & Payne, in press). Cognitive science has not, however, largely permeated the Army's instructional paradigm. Bloom's cognitive taxonomy (1956) is one instance of a cognitive approach that has been deeply integrated into Army training probably because the sequential, hierarchical nature of the taxonomy supports the existing predominantly linear approach to Army training paradigm. Merrill has also introduced some elements of cognitive psychology into Army training. Merrill's theory (1994) integrates learner control and assumptions about the cognition underlying learning into an instructional theory. The compatibility between Merrill's work and the current Army training paradigm is also found in a hierarchical or "levels" approach and a largely behaviorist approach.

A recent review (Hearn & Swanson, in press) examined the status of the military ISD to determine how services other than the Army were developing, implementing, and assessing computer-based training, especially in instances of highly cognitive training. Their overall conclusion was that despite an intense interest in cognitive science, spurred by advances in technology highly suited to representing cognitively oriented instructional approaches, most instruction being delivered in the military (including multimedia instruction) is still largely based on behavioral psychology.

Reeves (1996) provides a framework of 14 "pedagogical dimensions," which enables a more precise characterization of the current Army training paradigm. Pedagogical dimensions refer to the basis of instruction or capabilities of instruction to create learning progress, teacher effectiveness, or student interaction. He constructed the framework to support the systematic evaluation of computer-based education, which also provides a general conceptual map by which to characterize an instructional approach. The 14 dimensions are represented as continua and are shown in Table 13.

The supporting theoretical framework across Army training environments can be described as behavioral, instructivist, and objectivist. The theoretical basis for current Army training is implemented in a range of learning situations. Unit training is often implemented in a

variety of simulated situations using expert observation, judgment, and feedback. Linear, instructor-centered training is often found in school settings.

Table 13
Fourteen Pedagogical Dimensions (Reeves, 1996)

	1. Epistemology	
Objectivism		Constructivism
	2. Pedagogical philosophy	
Instructivist		Constructivist
	3. Underlying psychology	
Behavioral		Cognitive
	4. Goal orientation	
Sharply focused		Unfocused
	5. Experiential value	
Abstract		Concrete
	6. Teacher role	
Didactic		Facilitative
	7. Flexibility	
Teacher-proof		Easily modified
	8. Value of errors	
Errorless learning		Learning from experience
	9. Origin of motivation	
Extrinsic		Intrinsic
	10. Accommodation of individual differences	
Nonexistent		Multi-faceted
	11. Learner control	
Nonexistent		Unrestricted
	12. User activity	
Mathemagenic ^a (information presented to)		Generative (knowledge created by learner)
	13. Cooperative learning	
Nonexistent		integral
	14. Cultural sensitivity	
Nonexistent		Integral

^aMathemagenic is a term coined by Rothkopf in 1970 to refer to "those activities that give birth to learning," such as "systematic eye fixations while reading."

According to classic behaviorism (Skinner, 1968), learning can be understood not by the internal state of the learner but by observable behavior. Instruction consists of shaping behaviors that can be directly observed. Cognitive psychology places more emphasis on internal processes of learning. “[V]irtually all self-respecting instructional design theorists now claim to be cognitivists...[and] recognize that a wide variety of learning strategies may have to be employed in any given instructional setting, depending on the type of knowledge to be constructed” (Reeves, 1996, p. 5). Despite the claimed shift in perspective by instructional theorists, behavioral psychology continues to be the underlying psychology for many forms of computer-based education in general (Reeves, 1996) as well as much of military training.

Instructivism and objectivism complement and support the behavioral approach to training. Instructivists stress the importance of goals and objectives that exist outside the learner, which are drawn from the knowledge domain. Goals and objectives are sequenced from lower to higher order learning. Likewise, objectivists believe that knowledge exists separately from knowing and from the learner. Objectivists establish the definitive structure of the knowledge domain, based on SMEs, and they organize this information for students. They are concerned in instructional design with assuring that the content of the instruction is clear and accurate.

A criterion-referenced or standards-based system is the format for both Army institutional and unit training and reflects the behavioral, instructivist, objectivist perspective. Tasks are generally analyzed and then sequenced in a hierarchical manner and tied to performance standards. Task analysis to “decompose” knowledge, skills, and abilities into their hierarchically arranged component parts is a core skill in Army training development. The Army training development paradigm has been thoroughly codified, promulgated, and implemented in numerous research and training development efforts.

Fully exploiting the capabilities of a hypermedia platform may, however, depend on a shift to an approach that is in some ways diametrically opposed to the Army’s current training paradigm. Such shifts are accomplished only when evidence is overwhelming and a critical mass of a professional community believe that the previous approach should be superseded. Kuhn (1962), in his history of scientific revolutions, thoroughly demonstrated the extreme difficulty of shifting perspectives or paradigms in a domain, despite supporting research findings. Such a shift will be no easier in the U.S. Army’s training paradigm than in any other domain. While such shifts are not easily accomplished, several factors support a shift in the training development paradigm, at least at the advanced levels of training. The current adoption of the Force XXI operational perspective, the state of technology, and various cognitively based training research

programs already in place have initiated a philosophical platform that may support a shift to a new training paradigm.

The Renaissance of Constructivist Theory

Creating or selecting an instructional paradigm depends, in a general sense, on an understanding of how people learn. Our choice of a new theory on which to base a model of advanced learning is predicated on a cognitive perspective of learning. In addition to FAOAC training being taught at the more complex cognitive levels, it was assessed that much of the small group training can be described as the "art" rather than the science of fire support. *Art is defined here as an area or domain of knowledge in which there is no one right answer in any given situation, and the application of principles is not precisely uniform in varying situations.*

It was concluded that the art of fire support requires learning in a flexible manner, across a number of case studies, so that knowledge can be assembled by the learner in an appropriate and often unique manner for each new application challenge in the future which may not even be anticipated during training. An instructional approach that supports the Army's vision of a hypermedia instructional platform and guides the production of efficient, effective advanced training was the desired goal of this review. The educational literature reflects a current, widespread renaissance of the constructivist approach as the state of the art in instructional theory and research.

The renaissance seems to be driven by advances in hypermedia-educational technology that make new instructional approaches possible but require a revised educational paradigm for full exploitation. The "tenets" of the constructivist approach closely matched the selection criteria, and the literature has reflected a movement toward that paradigm among other branches of military service and others engaged in hypermedia-based training development.

Because constructivism (a) supports the methodical exploitation of "authentic" training environments (such as simulations); (b) provides a framework for planning, using, and evaluating the potential of hypermedia, more fully perhaps than a behaviorist, objectivist approach; (c) promotes student-centered learning; and (d) emphasizes higher order cognitive skill acquisition including knowledge management, retrieval, and hypothesis, this theory was explored as the basis for a paradigm for advanced officer training development.

Constructivism is a large field. A range of adherents is represented in the literature from conservative to radical constructivists. Conservative constructivists, for example, may advocate

the use of a constructivist approach only in some advanced education and training. Radical constructivists advance the view that a constructivist approach should be used in all types of training with all types of audiences. Several factors are often associated with constructivism: situated learning, cognitive flexibility, collaborative learning, learner control and motivation, and scaffolding and coaching. The remainder of the literature review describes the instructional tenets of constructivism and how they can be integrated into a training paradigm appropriate for advanced military training.

While both objectivism and constructivism adhere to the epistemological perspective that it is a real world we experience, an objectivist assumes that the knowledge domain is structured in the real world outside the learner. Objectivist “front end analysis,” as is found in much of the military training and performance literature, decomposes the aspects of the knowledge domain and their relationships. Instruction provides a guide to the structure of the domain and prompts the learner, through feedback and rewards, toward a mastery of the information structure.

Behaviorism is one type of objectivism, but the two are not synonymous. A cognitively oriented theorist concerned with internal processes of learning can still be an objectivist. The cognitive objectivist also seeks to make explicit the rules and relationships in a knowledge domain so that the domain can be acquired more readily by others.

Constructivism is an alternative to objectivism in its assumption that meaning is imposed on, rather than found in, the world. Therefore, there are many ways to structure knowledge or meaning for any domain, event, or concept. Constructivists assume that meaning or knowledge is “indexed” by experience. Experience becomes a part of the knowledge and is critical to the learner’s understanding and use of the knowledge (Duffy & Jonassen, 1992).

“It is not that constructivism is a new perspective. Rather...two changes in our society—the volume of information we must manage and the new opportunities provided through technology—have caused us to revisit constructivism (emphasis added)” (Duffy & Jonassen, 1992, p. ix). Traditional models of learning emphasize mastering the given information in a content domain. At a time when the information in a domain is constantly changing and incredible amounts of information are available, the mastery model has been questioned. A new learning model built on managing information, generating learner issues, and testing hypotheses is often more appropriate to the types of problem solving seen today. Technology has only recently advanced to the point where such an instructional strategy is viable across a large number of settings. Instead of the content mastery model, constructivism offers a model of cognitive apprenticeship.

The learning goal is not to master the content but rather to understand and use information to solve a real-world problem. Instructional goals and mastery are determined by the individual—they are not externally imposed...While topics are specified, the instructional sequence and the details of what is learned arise out of the work rather than being designed *a priori*...[L]earning is seen to be situated in the work context, with the meaning derived from the context. — Duffy & Jonassen, 1992, p. x

Situated Learning and Inert Knowledge

Constructivists emphasize situating learning in authentic experiences that motivate the learner to solve intrinsically interesting problems. Learning is always contextually dependent, and authentic situations enhance the learner's ability to incorporate information and understand its uses in performance. These experiences need not be literal apprenticeships in an actual work setting, and much of the current work in this field is concerned with the simulation of authentic problem-solving contexts through hypermedia.

The concept of situated instruction was influenced by Whitehead's 1929 discussion (as cited by the Cognition and Technology Group at Vanderbilt [CTGV], 1990) of inert knowledge. "Inert knowledge is knowledge that can usually be recalled when people are explicitly asked to do so but is not used spontaneously in problem solving even though it is relevant" (CTGV, 1990, p. 2). The assertion made by Whitehead was that the presentation of knowledge in schools is particularly prone to produce inert knowledge. Such authors as Dewey (1933, as cited in CTGV, 1990) discussed the concept of knowledge as tools. The idea is that when people learn new information in the context of meaningful activities, they are more likely to see the knowledge as a tool to be used rather than as an abstract set of facts.

The goal of situated learning is to overcome the inert knowledge problem.

Transfer of schoolhouse learning to the field is, of course, a crucial aspect of military training. Without learning transfer, expensive and time-consuming training is wasted and must be basically re-taught in the field rather than being refined by field experience.

An incredible example of inert knowledge was produced in a series of experiments by Perfetto, Bransford, and Franks (1983, as cited in Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990). College students were given word puzzles such as

a. Uriah Fuller, the famous Israeli super-psychic, can tell you the score of any baseball game before the game starts. What is his secret?

b. A man living in a small town in the United States married 20 different women in the same town. All are still living and he has never divorced one of them. Yet, he has not broken the law. Can you explain?

Across several studies, performance in baseline groups given such questions to solve was poor (18 to 25% correct). Experimental subjects tested after the baseline was established were provided answers by being asked before problem solving to rate the truthfulness of such statements as

- a. Before it starts, the score of any game is 0 to 0.
- b. A minister marries several people a week.

Experimental subjects who were told the relevance of the information given used the information in the problem-solving phase of the experiment and scored about 80% correct. Subjects who were given the information but were not told about the relevance of the statements to the problem-solving portion of the experiment did not do significantly better than the baseline subjects. Subsequent experimentation by Adams (in press, as cited by Bransford et al., 1990) also indicates that subjects will not use knowledge appropriately across experimental sets because of some generalization such as “catching on” to the experimental structure. There was no spontaneous use of knowledge after a number of trials. Performance only increased when specific instruction about how to use knowledge was introduced. In short, relevant knowledge given in a timely manner remained unused unless the learners were told explicitly how to apply it to a particular task.

The goal of constructivist instruction is to help the learner experience a problem and then to experience how information can function as a tool to solve that problem. Bransford et al. (1990) refer to the act of students “conditionalizing” their knowledge, that is, to acquire knowledge “in the form of condition-action pairs mediated by appropriate goal-oriented hierarchies rather than as isolated facts” (p. 120). One example of conditionalized knowledge is in the proper understanding and use of proverbs (the kind often seen on children’s intelligence tests). Proverbs actually contradict each other at times, and conditionalized knowledge provides the individual with the ability to use the proverbs appropriately. When a learner perceives new information as trite or old, as is often the case when information is given out of context, the knowledge will not be applied appropriately. In general, the way in which knowledge is first learned plays an important role in how the knowledge will be used.

"Brown, Collins, and Duguid (1989) were the first to...produce a proposal for a model of [situated] instruction that has implications for classroom practice" (Herrington & Oliver, 1997, p. 2). Brown et al. (1989) argued that inert knowledge is avoided only when learning is embedded in the social and physical context within which it is to be used. They discussed the concept of cognitive apprenticeships designed to "enculturate students into authentic practices through activity and social interaction" (p. 37). They also found a legitimate role for observation of authentic activity by novices who later progress to participant roles.

The CTGV (1990) proposed its own model of situated learning called *anchored instruction*. Central to the instructional model is the creation of an anchor or focus that generates interest. The created environment allows students and teachers to *sustain exploration*, and that enables them to understand the kinds of problems and opportunities experts encounter, the knowledge that experts use as tools, and the value of experiencing a problem from multiple perspectives. Students identify the problems and solutions and pay attention to their own perception and comprehension as they develop.

The anchor provides a focus for the students' perceptions and comprehension. Ideally, the anchor is intrinsically interesting and will motivate students to address a general goal (such as planning a trip, constructing a fire support plan, or improving a business process). "Effective anchors should also help students notice the features of problem situations that make particular actions relevant" (Bransford et al., 1990, p. 123).

Many educational experiences involve multiple case studies or *microcontexts*. The CTGV prefers to develop *macrocontexts* as anchors to enable the exploration of a problem space for an extended period of time and to support teacher mediation opportunities and student collaboration. The CTGV found that observation in the learning contexts is even appropriate for novices as it begins to allow them to form a conceptual map for the introduction of new knowledge rather than the introduction of facts out of context.

The CTGV prefers to use visual contexts rather than text, since visual contexts better support pattern recognition skills. Rich mental models are especially important for novices to begin to understand the "trigger" conditions during which knowledge should be accessed. A simple example given is that of the art of clinical psychology diagnosis (CTGV, 1990). A verbal description of symptoms to train students is not useful without accompanying auditory and visual clues that are given only in video or real-life representations. The macrocontexts produced by the CTGV are created on video disk to provide for random access of information and the juxtaposition of varying selections as needed for comparison.

Research by the CTGV has demonstrated superior learning in anchored instruction groups as compared to control groups. One example of a macrocontext was the use of the movie "Young Sherlock Holmes" on video disk to teach story writing to fifth graders. The context was used to teach all aspects of story writing (e.g., initiating events, character development, differentiation of protagonist and antagonist, setting). Students in the control group used a number of different stories as is typical of reading programs, each to illustrate a different concept. Data indicated that (a) students in the macrocontext wrote stories with more elements, (b) plots linked characters and events to goals more often, (c) students used targeted vocabulary more frequently, and (d) students produced higher quality classroom discussions (CTVG, 1990).

A second example of anchored instruction within a macrocontext is the Jasper Series (CTGV, 1992a). That project has enabled sixth grade school students to learn science, history, and literature concepts. The first disk featured a very complex mathematical problem (completing a trip before sundown) that involved the generation of about 15 subgoals. The complexity was intentional. Learning goals should be more complex than any one individual can address to encourage student collaboration. Another key design feature is "embedded data design." Students generate problems and then have to find the relevant information to solve the problems throughout the macro context. Many facts are embedded in the design, and various problem scenarios can be implemented. The Jasper Series replaced traditional math word problems that were given without a context and tended to become ends in themselves. No control group was used.

Students who had scored above average on mathematics achievement tests were selected to be taught mathematics using the Jasper series. They were not provided with any problem formulation or problem-solving instruction to introduce the series. Problem generation and solving were found to be good, and collaboration was facilitated in the experiments. Students devised their own roles (e.g., some who were not as proficient at math were sometimes better at noticing relevant information in the scenario). *Evidence also suggested that transfer of knowledge was facilitated when there was emphasis on analyzing similarities and differences among problem situations.*

In implementation of the Jasper Series with students at least one grade level below their peers in mathematics, a control group was given tutoring, and an experimental group used anchored instruction (Bransford et al., 1990). The experimental group received one-on-one instruction, feedback about the strengths and weaknesses of their approach to each problem, and were encouraged to create visual and symbolic representations of problems. The control group

received one-on-one instruction, worked on a number of problems, and each student was shown the correct solution strategy after each problem. Students in the control group showed very little improvement in math skills. Students in the experimental, anchored instruction group showed much improvement in the problems and in generalizing out of context.

College students in a control group in a study by Sherwood, Kinzer, Bransford, and Franks (1987, as reported by Bransford et al., 1990) were given 13 science passages of middle school and high school level to read. The experimental group was given the same information but in the context of problems that might be encountered by "Indiana Jones" on a trip to South America. There were large differences between the two groups. Students in the experimental group recalled more of the 13 topics than the control group. Students in each group were also asked to spontaneously use the information in the context of a new problem situation. Students in the experimental, learning context group used more of the information and used it more specifically in the new context situation.

The question of whether the novice can enter a complex, authentic learning environment and develop expertise is addressed by the CTVG, which asserts that there will be a significant impact only if students have the opportunity for extended practice in related problems and that the macro context becomes more authentic as students have an opportunity to develop their own related materials.

Multiple Perspectives

A situated learning context should provide the learner with the opportunity to investigate the domain from multiple roles and perspectives. Many multimedia applications are designed in a linear instructional format. The learner must begin at the beginning and work through successive modules in a prescribed sequence. An application that fully exploited hypermedia would be integrated in such a way that the same material could be explored repeatedly from a number of perspectives.

Students must not only be exposed to multiple viewpoints but must have the opportunity to construct and evaluate multiple interpretations or understandings of a situation. Young (1993) described the repeated use of the Young Sherlock Holmes film as invoking images of "students bored to tears when viewing the film for the tenth or thirteenth time. But...it was the changes in understanding that proved motivating, not the original presentation of the situation" (pp. 49-50). "...[C]onstructed understandings do not mean that any interpretation is as good as any other but rather that there is a social negotiation of meaning. A critical component

of learning and understanding is the ability to evaluate alternative understandings in terms of their usability” (Duffy & Jonassen, 1992, p. 12). This process is true in all areas of life, and the encouragement of collaborative learning defined as social negotiation of multiple viewpoints should provide a valuable concept to improve the transfer of learning in military training.

Collaborative Learning

Del Marie Rysavy and Sales (1991) reviewed 13 research reports published in the 1980s involving collaborative learning in computer instruction. The purpose of the review was to assess the empirical basis supporting the effectiveness of the collaborative approach as opposed to individual instruction with computers. They examined (a) achievement and ability levels, (b) patterns of study, (c) social interchange, (d) motivation and attitudes, and (e) gender comparisons.

Achievement results are mixed. Some studies found increased achievement in learning when a collaborative computer-based approach was used; others found no difference between the two approaches. No studies found a decrease in expected achievement as a result of collaborative learning. Groups of mixed ability were not shown to impair the achievement of high ability students but did raise the achievement levels of low ability students. Ability was not a factor in how much contact time students in a mixed ability group spent with the computer.

Patterns of study were influenced positively in the studies reviewed. Students were able to work faster and use more of the factual information learned in problem solving. Students worked together to interpret problems, resulting in a more accurate understanding of problems presented through convergence of multiple viewpoints. Students tended to use each other as resources more often and spent more time on practice items as they attempted to reach consensus.

Interactions in collaborative working groups are often suspected by teachers to cause counterproductive socializing. This belief was not supported by the research reviewed. Interaction among students was almost all task oriented in cooperative groups and was more off-task in competitive and individualistic learning conditions and when students worked in pairs. Group learning did not show the usual correlations found between positive attitudes with successful learning and negative attitudes with lack of success. The researchers cited believed that the social dynamics of collaborative learning overcame the usual relationship of attitude with individual success.

Students in collaborative groups seemed to motivate each other to seek elaborate feedback to their responses and to persist longer in attempts to accomplish goals. Research also found "that cooperative learning, compared to competitive and individualistic learning, equalized the status and respect for all group members, regardless of gender. The participation patterns were more equal..." compared to other settings (Del Marie Rysavy & Sales, 1991, p. 77).

Situated learning environments are designed to stimulate collaborative learning. Complex macrocontexts necessitate a collaborative approach. The problems presented are usually too complex for an individual to solve, as is the case in many real life domains. Effective group interaction is not guaranteed by merely using a collaborative learning environment. The instructor must still facilitate interactions such as by assigning roles by teaching and prompting the use of specific collaborative skills. For example, "four major collaborative skills that need to be taught to promote effective cooperative learning are leadership, communication, trust building, and conflict management" (according to Johnson & Johnson, 1986, as cited in Del Marie Rysavy & Sales, 1991, p. 70).

To create deep learning, it is essential that students seek to create the best possible understanding of different vantage points. Collaboration is not meant to be just a sharing of a single viewpoint or a sharing of tasks but a sharing of multiple viewpoints. Examples are very useful in stimulating such an interchange. Constructivists do not advocate the use of carefully chosen examples that exemplify a concept but rather the exploration of slices of life, since ideal, carefully chosen examples are seldom available in real life. This approach maintains the emulation of the complexity of problem solving, which will later be encountered by the students in the natural environment.

Merrill (1992), a more traditional instructional theorist, argues that collaboration is not appropriate for all learning situations. There are times when individual learning is more efficient and more effective. This assertion must be carefully considered in the case of FAOAC in which a blend of individual and collaborative learning may be appropriate. He also argues that the presentation of well-chosen examples, rather than slice-of-life exploration, is also more efficient, even if it is not a reflection of real life. Life is not nicely organized, but Merrill asserts that this generates the need for instruction, which is more efficient than only learning from experience. While this argument has much face validity, it assumes that constructivist instruction has a *lack* of structure rather than a different or more complex structure.

Concept Mapping

One technique, rooted in cognitive information processing theory, which may be useful in facilitating the structure of advanced instruction, is concept mapping. "Concept mapping...is a useful strategy for sorting out initial concepts...[It] allows you to combine elements into meaningful statements or propositions...[and] to see the relationships between concepts and build on their conceptual framework" (Hedberg & Metros, 1997, p. 3).

A concept map is a two-dimensional, graphical structure representing ideas and their associations. The design of the maps reflects the associative way the brain works in storing knowledge and experience as the maps are composed of ideas and their connections. They are more economical than text for representing complex information, and they are easier to read than text covering the same information. Concept map generation can be used by individuals or groups as evidence of their collaborative understanding. Once constructed, the maps can be used by the learner to provide a structure for later integration of new knowledge.

When a concept map is constructed, it should be hierarchical in that it should be constructed from the most general idea to more specific concepts within a domain. The individual or group needs to validate the connecting verbs between ideas. Various linkages should be examined to look for connections not previously identified. Maps can also be constructed without verbs between the entities in the form of mind maps. Two simple illustrations of concept maps are provided in Figure 9 as presented in Hedberg and Metros (1997, pp. 4-5).

Concept maps can be used by designers to plan the web-like structure of hypermedia applications. Complete complex, cognitive maps representing domains as understood by experts would be too complicated to use for an orientation for novices and intermediates. Using the maps to structure a hypermedia tool could be useful, however, as long as the connections and entry points could be used flexibly according to the level of the learner so that the novice does not get lost. The application of concept mapping to classroom instruction or knowledge construction in class would be experimental in the FAOAC, as this technique has not been used in either way in the course.

Scaffolding and Coaching

"One of the greatest challenges that anchored curricula pose for teachers derives from the need to change their role from a provider of information to a coach and often a fellow learner" (CTGV, 1993, p. 53). Generally, the teacher and the students become task managers. The strategy of managing one's own learning is supportive of students becoming autonomous

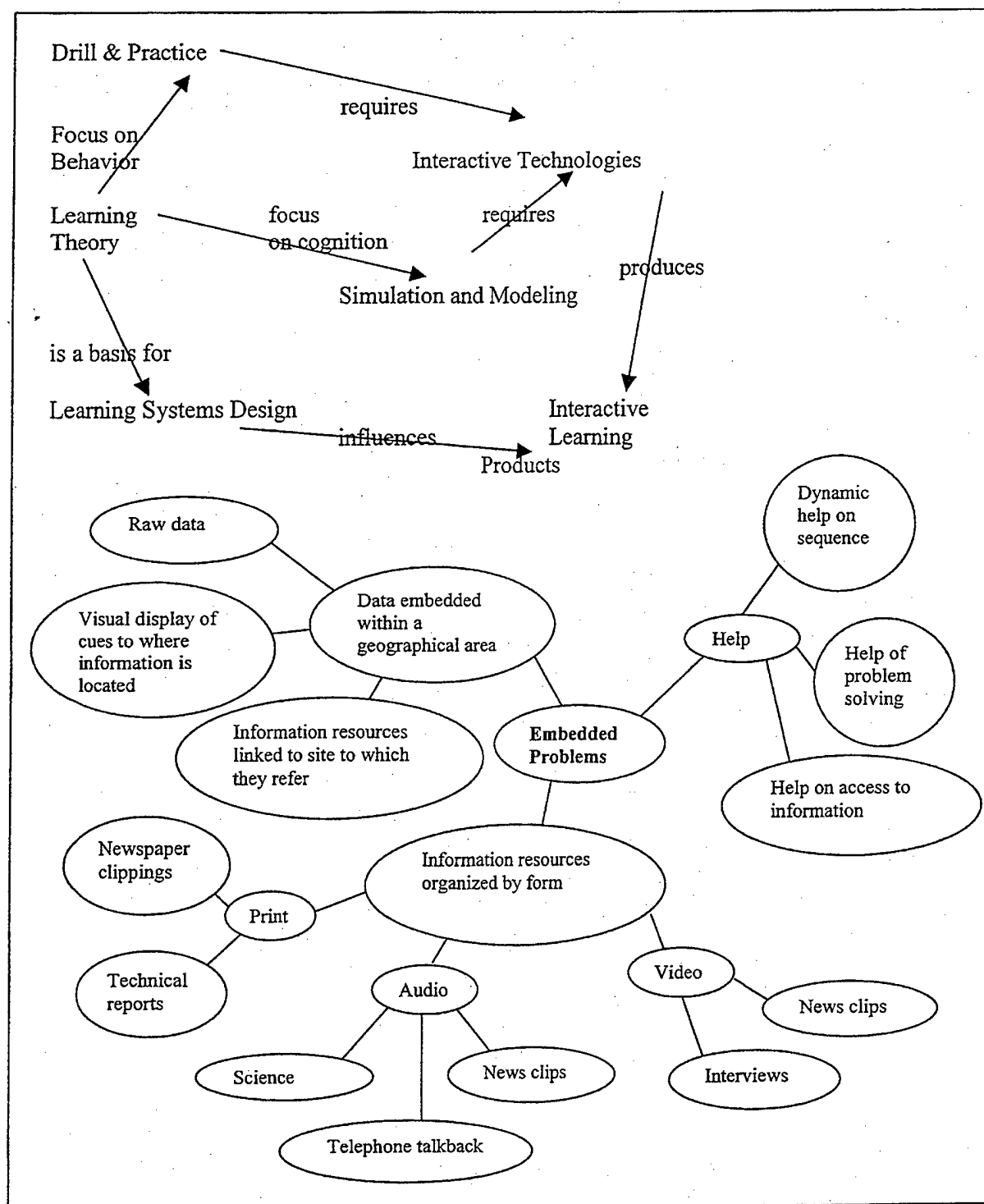


Figure 9. Examples of concept maps (Hedberg & Metros, 1997, pp. 4-5).

thinkers and learners. Many students are so unaccustomed to self-management, however, that “they fend poorly” (Perkins, 1992b, p. 163). The CTVG (1992a) encourages teachers to use scaffolding and coaching at critical times in the problem-solving process to help the students move forward—not to introduce concepts through direct teaching. For example, if a student has a good approach to a problem but lacks the math skill to implement it, the teacher may facilitate by teaching a particular procedure. A teacher is an excellent source for finding reference material. Teachers may also demonstrate how to create “manipulatives” such as charts to keep track of measurements. At times, the computer or video-based context may also embed scaffolding such as how to read a chart or use a map. The teacher’s job is “to hold the learners in their ‘zone of proximal development’ by providing just enough help and guidance, but not too much...[T]his happens in many naturalistic situations such as mother-child relationships and apprenticeship settings” (Perkins, 1992b, p.163).

The zone of proximal development as espoused by Vygotsky (1978) is the concept that each learner has areas where he or she can accomplish more and solve more advanced problems when appropriately supported by a more advanced student or teacher than he or she could accomplish alone. Facilitating these opportunities aids the learner in making leaps in competency.

To facilitate teacher effectiveness, the CTVG (1993) found in 3 years of research that it was important to introduce simple technologies into classrooms at the beginning of a conversion to a constructivist approach, as the teacher is simultaneously changing the culture of the classroom. Planning time and technology support were important to avoid losing learning time for students.

Other than these recommendations, very little information was found in the literature regarding teacher preparation to function in a constructivist environment. What was found generally applies to management of elementary and middle school classrooms. Coaching and scaffolding techniques may not be part of the teacher’s training or be specified in a course design. The procedures used need to be specified since they may influence the instructional design implementation.

Learner Control and Motivation

“Central to the vision of constructivism is the notion of the organism as ‘active,’ not just responding to stimuli, as in the behaviorist rubric, but engaging, grappling, and seeking to make sense of things” (Perkins, 1992a, p. 49). If learners are not just passive receivers of

information but interpreters of experience, how then do instructional designers create environments that best support the construction of knowledge? To accommodate and facilitate the active construction of knowledge, the learning environments should allow for learner control and should provide for articulation, reflection, and stimulation of motivation.

Learner control refers to the latitude that an instructional approach affords a learner to make his or her own path through a program, control the pace of work, access feedback, and decide how much assistance is needed. Interface design and instructional design can both support learner control. As noted before, hypermedia are ideally suited to provide learner control since entry points, paths, timing, and complexity can all be controlled by the user.

Learner control has two sides. While it may be motivating and useful for a learner to control his or her exploration of a knowledge domain, it can also be frustrating and ineffective for learners who are not ready to self-manage. More effective learning and motivation are only achieved when users are able to handle the high levels of control available (LaFollette, 1993, as reported in Stoney & Wild, 1997). Optimizing the use of learner control can be mediated by the use of advisement, that is, the system makes suggestions to the learner, which he or she can choose to use or ignore (Ross & Morrison, 1988, as reported in Stoney & Wild, 1997).

A review of learner control research (Williams, 1993, as cited in Reeves, 1993) indicated that learner control increased learner engagement and attitudes in some cases but did not necessarily lead to greater achievement. Reeves (1993) asserted that learner control research is inconclusive at best and methodologically flawed at worst. Reeves believes the research is flawed in terms of definitions, theory, method, and analysis. Learner control is loosely defined in studies. The term may refer to rate and order of screen presentation in computer-based learning to exploration in a complex learning environment where the student virtually authors his or her own instructional program. Studies often fail to provide theoretical grounding for predicting how and why learner control may be beneficial. Many studies did not provide learning experience of sufficient frequency or duration to involve the learner in a self-controlled experience, such as findings based on single treatment applications of fewer than 30 minutes. Analytically, such studies have tended to use too few participants to support statistical analysis, and they do not relate their analysis to theoretical predictions.

Constructivist designers have explored how the adult student can best be motivated to move through a learning process and have concluded that the literature suggests (Stoney & Oliver, 1997) that the ability to explore and experience in the learning situation (one definition of learner control) is a key motivating factor. The premise for studying motivation is

that increased time of engagement with the material to be learned, that is, sustained exploration within a knowledge domain, will lead to better learning.

Stoney and Oliver's review of the literature revealed "that there are a number of discrete factors that are important determinants and significant contributors to the development of...motivating computer-based...learning environments," particularly for adult learners (Stoney & Oliver, 1997, p. 24).

The eight factors identified by Stoney and Oliver are

- immersion
- reflection
- flow
- collaboration
- learner control
- curiosity
- fantasy
- challenge

Immersion refers to being both physically and psychologically absorbed in the learning program's content. In total immersion, the sense of self, time, and self-consciousness disappear, and the process is experienced as extremely gratifying and intrinsically motivating. Computer games are good examples of the motivation that can be achieved by immersion (the willingness of the user to play for the sake of playing and not for any specific external rewards) and the powerful drive to obtain knowledge for the purpose of using it to solve problems. Immersion is based on engagement in activities perceived as authentic and the lack of distracting gender or other bias in an activity.

A method of reflection should be incorporated into the learning process. Students should experience an activity, reflect on the activity, including articulating what was learned and how, apply this reflection to the task, and get feedback to validate or modify their understanding.

Motivation can also be tied to the student's entry level ability. The entering FAOAC students show a wide range of ability levels, and this makes it difficult to engage some students in the learning process. A flow state results from immersion that appropriately integrates growth and discovery of the knowledge domain with one's own abilities. The flow state is a state of consciousness in which performance, learning, and satisfaction are optimal. The flow state identified by Stoney and Oliver from the work of Csikszentmihalyi (1992) seems to be the result of immersion, reflection, and a balance of challenge with ability level.

Figure 10 is adapted from Csikszentmihalyi (1992) and illustrates the balance needed between challenge and ability to achieve flow. Too little challenge, when nothing new is encountered, results in boredom and lack of motivation. Too much challenge is overwhelming and results in frustration and failure and ultimately a loss of motivation. Challenge is enhanced when a learning program has inherent goals (or creates the conditions for learners to define goals in order to engage in the process).

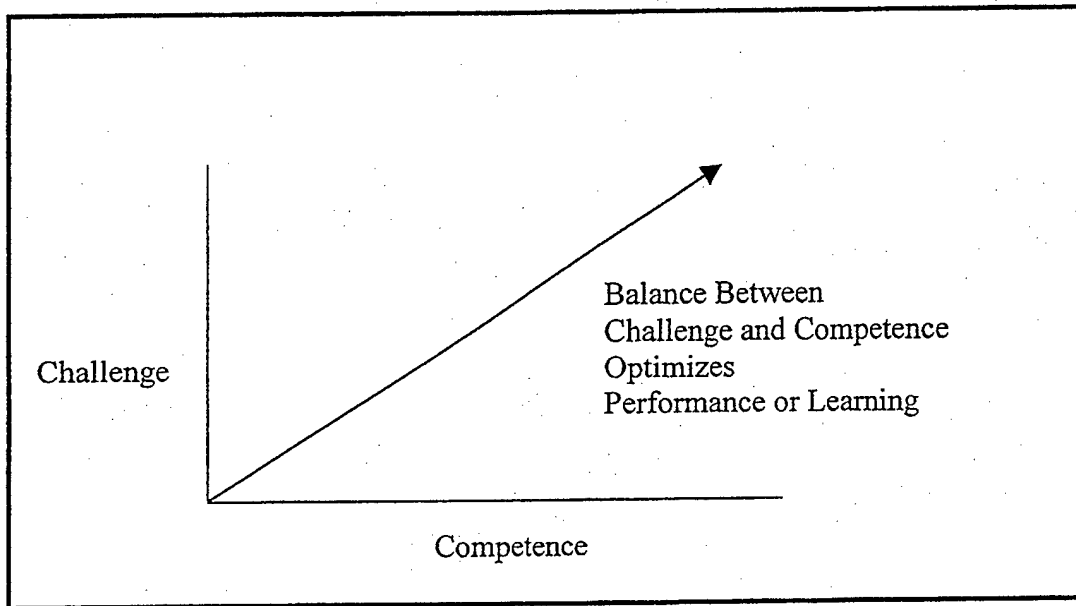


Figure 10. Optimal balance between challenge and competency (adapted from Csikszentmihalyi, 1992).

The optimal learning or performance state can only be sustained if curiosity, like challenge, can be aroused and satisfied. Curiosity is not generally as strong in adult learners as in children. The adult learner can be stimulated to be more curious by the use of novelty, complexity, surprise, and incongruity. Fantasy can be used to impart novelty and encourage immersion. Fantasy learning settings can contain activities that are authentic and support learning. Simulations need not only be used to portray realistic activities in order to be called authentic and to provide a productive learning environment.

Assessment of Learning

In this section, the challenges and bases of constructivist assessment are examined. Assessment, as discussed here, refers to the evaluation of learning. Assessment can also be defined as evaluation and modification of the instructional strategy. "...[E]valuation of learning

from constructivistic environments is perhaps the most difficult issue related to constructivism..." (Jonassen, 1992, p. 138).

Assessment of constructivist instruction is based on a theory of situated cognition as a description of the underlying learning process. "Situated cognition involves reasoning with causal stories, acting on situations..., resolving emergent dilemmas..., producing negotiated meaning and socially constructed understanding..., and making sense out of complex, unclear data to solve problems" (McLellan, 1993, p. 43).

Constructivism makes a specific and coherent set of assumptions about both the learning process and the desired learning outcomes. The process is seen as one in which the learner becomes increasingly aware of problems in a domain, establishes subproblems, goals to accomplish, and an equilibrium of understanding, and then annihilates these points and creates new ones based on an ever increasing understanding of the problem solution "state space" (Young, 1995). The learning process is described as

- being based on authentic tasks in a situated learning environment,
- using multiple perspectives and creating the ability in the learner to view a problem from multiple perspectives,
- relying on socially negotiated insights,
- supporting the learner in the construction of a web-like mental structure of knowledge and application links,
- providing at critical learning junctures, access to expert insight in the form of coaching and scaffolding to push the learner beyond where he or she could go alone,
- being inherently motivating to support sustained exploration of a knowledge domain,
- containing continuous feedback not as a reinforcement or shaping mechanism, but as a support to self-reflection, and
- supporting superior transfer of knowledge to post-instruction situations to overcome the problem of inert knowledge.

Authors have proposed that these tenets be used to guide the formulation of assessment methodology to test the paradigm's assumptions in basic research and to test the effectiveness of real-world learning environments designed according to constructivist principles. Authors such as Jonassen (1992), McLellan (1993), Young (1995), and Jacobson and Spiro (1995) have proposed frameworks, which are based on some version of the constructivist assumptions, to support the development of assessment methodology.

Generally, constructivists stress the need to seamlessly integrate assessment into the learning process as a continual feedback function of the learning process and not as a reward

for learning knowledge in a prescribed structure. *Assessment of the process and support for the learner's self-reflection are key. The process is seen as successful when the learner is able to build increasingly complex knowledge structures that allow him or her to access information and principles and apply them across a variety of situations in the learning environment.* Successful learning outcomes are defined as the ability of the learner to transfer learning to effective problem solving in novel situations. The unit of analysis for assessment is the interaction that occurs between the individual and the problem situation.

Schon (1987, as cited in McLellan, 1993) proposed a set of criteria useful for characterizing the advancement of the learning process. The criteria, as shown in Table 14, could be used to structure advanced learning assessment.

Table 14

Criteria Indicating the Advancement of Learning
(adapted from Schon, 1978)

Closed vocabulary	→	Substantive understanding
(Knowledge of terminology versus an understanding of the terminology related to actual actions, events, processes)		
Unitary procedures	→	Holistic grasp
(Ability to perform discrete procedures versus an ability to combine procedures or parts of procedures within a process)		
Narrow and superficial	→	Broad and deep
(The ability to solve one problem or to see one procedure as an exemplar versus the ability to tailor or design procedures to a wide range of situations)		
Overlearning	→	Multiple representations
(Over-reliance on one "right" way or viewpoint versus a way of thinking and doing that is critically analyzed and juxtaposed and combined with other views)		

Evidence of learning in constructivist instructional settings is not required to be demonstrated independent of technological and knowledge aids such as in knowledge

memorization tests presented in content mastery assessment. Appropriate use of performance aids (e.g., knowledge bases of any kind) are seen as a part of problem-solving ability. The purpose of assessing the learning process is to externalize the perceptions of each problem solver, for example, reconstruction of the cognitive process.

Evidence of the learning process can be obtained in several forms. Externalization of perception might include verbal reports as an attempt to obtain insight into the cognitive process without resorting to reconstruction. Verbal reports are, however, extremely limited as the least amount of verbal reporting is obtained at the most critical times perhaps because of cognitive overload or cognitive conflict at these times. Concept mapping or video tape coding can be used as problem-solving reconstruction techniques.

As collaborative problem solving unfolds, the computer can be used to collect information such as the nature of the interaction, definition of problem space, the knowledge discovery process, and problem sub-component development. Paths through information, accessing of irrelevant information (*which has been shown to lead to information overload*), misconceptions (error patterns), and time spent on various problem aspects can reflect these elements. Concept maps could be constructed from these elements. DL could incorporate computer recording of these elements (Young, 1995).

Portfolios of ongoing work exemplifying the conceptual growth of an individual provide a map of his or her exploration of a knowledge domain, although portfolio assessment is labor intensive. Similar to portfolios, students can design instruction for other learners as a situated activity. These student-designed instructional materials can be assessed, based on the quality of the product, the success of the product as learning material, and the process of its creation. "An expert's skillful postmortem of the problem-solving process...can [also] serve as a focus for reflective comparison and discussion, as can the students' postmortems of their own problem-solving process" (McLellan, 1993, p. 42).

A modest number of studies have been conducted in the area of constructivist assessment. Jacobson and Spiro (1995) presented one of the best integrated studies to date in which they designed a learning experience based on features of their Cognitive Flexibility Theory (a type of constructivism), evaluated the student's ability to use the environment both attitudinally and as a function of reading comprehension, and statically related these factors with learning outcomes. To avoid confounding the findings with learner control variables, the nonlinear linking of material in the experimental treatment was maintained, but subjects were not

allowed to discover their own path through the domain. Therefore, post-instruction knowledge transfer, not the learning process, was the area of assessment.

This empirical test of research hypotheses from Cognitive Flexibility Theory was devised as basic research to test the theory's ability to predict how instruction can be designed to increase knowledge transfer. The main result of this research was that students using the instruction that interrelated concepts and a variety of cases reviewed from several perspectives were superior in post-instruction performance on essay tests meant to measure the employment of the concepts in new cases. Students in the control group, who were given more traditional computer-based instruction drills in the concepts and a linear approach to the use of case studies, achieved higher scores on memory-oriented factual knowledge items related to the domain of study.

Beliefs about the nature of learning seemed to act as a control function over the learning process, and they influenced post-instruction performance. Students who believed in the web-like structure of knowledge and nonlinearity of the learning process benefited most from the experimental, nonlinear learning process. The same research structures could be used to evaluate learning environments designed for real-world application.

It is very difficult to compare two instructional paradigms (objectivist and constructivist) when the assessment methods of each somewhat invalidate the others. This is the nature of the time period between paradigm shifts in any field as knowledge undergoes social cognition to reach a new consensual reality (Kuhn, 1962). Instructional design theory is now at a cusp where that consensus has not been negotiated, and that makes discussions in a field during a transition difficult.

Knowledge transfer is the principal area where the difference in the two approaches is predicted to be most evident. When knowledge transfer is operationalized as problem solving in new situations, constructivist instruction yields superior results. Constructivists emphasize problem solving and perception instead of memory. In this time of information overload, the ability to recognize what information is needed and knowing where to find it is seen by constructivists as superior to the learning outcome of knowing the information in a domain.

What has not been attempted in evaluation is a type of "shoot off" in which constructivist and instructivist designers agree to the same instructional outcome goals, assessment, students, and content. Each would then be free to design his or her own instructional

environments and manage the learning process according to his or her own principles. Learning outcomes could be compared by an independent evaluator, assuming such an arrangement could ever be put into place.

The constructivist paradigm of instruction emphasizes perception instead of memory. Perception is operationalized as the individual's ability to interact with an "information field" (situation). Constructivist assessment means assessing performance during and after the learning process, rather than using post-instruction psychometric instrumentation as the evaluation method. Generally, constructivists stress the need to seamlessly integrate assessment into the learning process. In the limited number of studies in which constructivist assessment has been employed, learning process variables, student products, and knowledge transfer have all been the subject of measurement methodology.

The convergence of the Army's approach to advanced training and constructivist theory is most apparent in the dilemmas and possibilities of the assessment of constructivist instruction. Many of the assessment variables cited here can be seen in the AAR processes at the CTCs. Examination of constructivist assessment also provides insight into why the Army has had such difficulty applying assessment techniques to advanced, simulation-based, collective training such as at the CTCs. The difficulty can be summarized in two general themes: (a) Army trainers and researchers continue to attempt to measure a constructivist type of learning and training that is fundamentally different than the basic Army paradigm of training without specifying a new paradigm, and (b) constructivist evaluation is inherently difficult, even in controlled settings when the learning paradigm has been articulated.

Simulation-based training, which approximates in many ways a constructivist approach, is embedded in a training system that uses criterion-referenced measurement for every learning experience for the students until that time. Criterion references are desired or expected by students and training developers, yet learning process insights as well as attempts to tie processes to successful outcomes are needed. Tension arises from the efforts to tie cognitively based command and control process behaviors to criterion references or give feedback without such references and from the inability of simulations to sufficiently mirror realistic outcomes to validate processes.

To understand whether a student is proceeding toward a better perception of a domain (interconnections among concepts and the range of situations to which they apply), assessment of the learning process is necessary. Assessment of the learning process is also

needed to understand if the concepts upon which constructivist instruction are built are valid. Assessment of the transfer of understanding to a variety of different situations is also needed.

Implications for instructional design, addressed later in this document, are predicated on an understanding of the changing instructional outcomes for advanced military training to maximize performance on the digitized battlefield and on the inclusion of assessments to demonstrate that those goals are met as the training strategy is implemented.

Cognitive Flexibility Theory

One perspective on the constructivist design of instructional material particularly relevant to the Force XXI training challenge is presented in Cognitive Flexibility Theory (Spiro & Jehng, 1990; Sprio et al., 1992; Spiro, Feltovich, Jacobson, & Coulson, 1992a, 1992b). The theorists assert that while technology has advanced, the general instructional approach for using it has not changed in many educational and training settings. A conflict has arisen in that more sophisticated technology has led to the ability to provide very complex representations of knowledge, and instructional theorists have questioned why knowledge is still being presented in linear, discrete bits despite the lack of knowledge transfer that often occurs as a result. This argument is especially cogent in considerations of the presentation of information from cognitively complex, ill-structured knowledge domains.

Traditional methods of instruction rely on linear media...Linearity of media is not a problem when the subject matter being taught is well structured and fairly simple. However, as content increases in complexity and ill structuredness, increasingly greater amounts of important information are lost with linear approaches and the unidimensionality of organization that typically accompanies them. —Spiro & Jehng, 1990, p. 163

Cognitive Flexibility Theory focuses on providing a unified theoretical approach that will produce guiding principles for random access instructional design that fully exploits hypermedia capabilities. The authors assert that new instructional principles are needed not only to stimulate the appropriate use of hypermedia but also because *much of hypermedia production at this time is largely intuitive and individual in creation. A highly individualistic approach to instructional design leaves the field in the state where it is difficult to communicate or duplicate approaches.* Principles of design will provide a foundation for the more efficient production of hypermedia applications and will guide subsequent research.

Random access to knowledge does not imply a lack of structure. *The structure is multidimensional and web-like.* Random access instruction refers to the ability of the computer

to use an underlying structure to provide multiple entry points for a student to search for information to support hypotheses. Anyone who has used the internet will understand the nature of a web-like structure and the power of searching the web-like structure. Users of the internet are also aware of the tendency to get lost in their searches, especially as a novice. Such experiences reinforce the idea that multidimensional experiences are not the most supportive for all types of learning and that when used, hypermedia must support the learner's exploration path to avoid wasted time and frustration. Figure 11 (from Oliver & Herrington, 1997, p. 75) illustrates the range of complexity available in the architecture of computer-based learning materials with the advent of hypermedia.

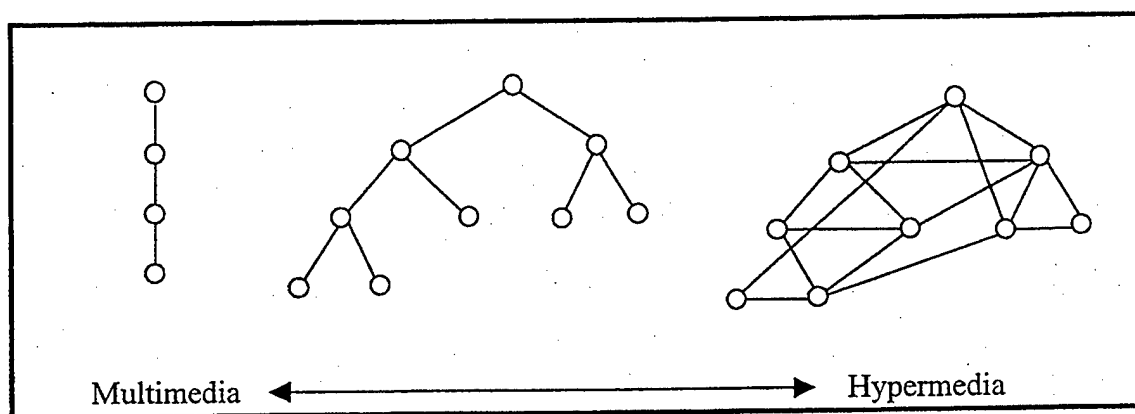


Figure 11. A continuum describing the architecture of computer-based learning materials (Oliver & Herrington, 1997, p. 75).

Cognitive Flexibility Theory is concerned with advanced knowledge acquisition (post-introductory learning) in specific content areas. Spiro and Jehng (1990) characterize advanced knowledge acquisition as "... complex and the relationships across the cases that knowledge has to be applied to become more irregular" (p. 165) as expertise advances. These ill-structured domains require different learning goals. The shift in goals is "(a) from the attainment of superficial familiarity with concepts and facts to the mastery of important aspects of conceptual complexity, and (b) from knowledge reproduction to knowledge...application" (p. 165).

In a complex domain, there is "nonuniformity of explanation across the range of phenomena..., nonlinearity of explanation, nonadditivity following decomposition, context dependency, [and] irregularity of overlap in patterns across cases..." (Spiro & Jehng, 1990, p. 168). This description conveys much of what is seen in advanced military training where different patterns of principles may apply differently, given changing contexts. Learning in

complex domains requires multiple representations of explanations, analogies, and dimensions of analysis. Learning in such a flexible manner provides "...the ability to adaptively reassemble diverse elements of knowledge to fit the particular needs of a given understanding or problem-solving situation" (p. 169).

Cognitive flexibility refers to the ability to spontaneously restructure one's knowledge in adaptive response to changing situations. The basic assumption of the theory is that traditional learning often depends on pre-selected generic knowledge structures demonstrated through selected cases. Such an approach is deemed too simple to support the transfer of knowledge in complex situations across cases with much variation.

Learning to use knowledge in a variety of ways in diverse circumstances cannot rely on rigidly prepackaged training schema (Spiro & Jehng, 1990). Standard courseware does not support the development of cognitive flexibility, and standard theories of instruction do not support advanced learning in ill-structured domains. Hypermedia is especially appropriate to such advanced learning but not necessarily to simply structured domains or introductory material. *The power of hypermedia technology to implement Cognitive Flexibility Theory is its ability to support the construction of a single courseware application that is essentially multiple texts for the same topic.* Spiro and Jehng (1990) assert, however, that work in hypermedia has tended to be atheoretical and driven by the technology rather than by a model of the learning process.

Cognitive Flexibility Theory, unlike other constructivist approaches, advocates the use of an eclectic instructional design theory. Whereas Cognitive Flexibility Theory is seen as applicable to advanced training, it is probably "the opposite of what works best for introductory learning and in well-structured domains" (Spiro et al., 1992a, p. 62). Thus, a second strategy should be combined with Cognitive Flexibility Theory to design a program supporting introductory learning according to its authors.

Work on theories of learning, instruction, and performance have tended to concentrate on novices and experts (Spiro & Jehng, 1990; Spiro et al., 1992a; Dick, 1992) and have largely ignored the intermediate level of learning. The intermediate level is probably much larger an area of learning than either of the extreme ends, and it forms the bridge for the novice to expert transition. Advanced officer training is typical of intermediate learning. There is an assumption that the incoming student has been introduced to the domain (has completed the officers' basic course) and has had some field application (completed several years in the field). It is also assumed that the refinement of expertise in the domain will come only after graduation

while the student is in following assignments. The FAOAC can be thought of as primarily an intermediate bridge between a novice's understanding of the field and the readiness to acquire an expert's understanding.

"The central metaphor of Cognitive Flexibility Theory is the 'criss-crossed landscape'" (Spiro & Jehng, 1990, p. 169). Generally, this concept means that ideas in a complex domain cannot be neatly categorized. Rather, concepts must be revisited from multiple viewpoints, and knowledge is constructed as the learner crosses the conceptual landscape from various perspectives. This strategy enhances the learner's ability to reassemble the information in unique ways for future problem solving and increases the range of situations to which a learner will be able to generalize. This need for knowledge transfer typifies much of the FAOAC small group instruction on the art of fire support. There are no right answers for each situation, and prepackaged information cannot be constructed to cover every possible situation and contingency that a graduate may later encounter in a battlefield environment.

"The mini-case (a segment drawn from a larger case) is the starting point for all instruction in Cognitive Flexibility Hypertexts" (Spiro & Jehng, 1990, p.181). The traditional use of cases in advanced learning tends to provide an overarching prototype that the learner may inappropriately apply in a subsequent situation. Mini-cases are not abstractions of the larger scenario but are small slices that may be just as complex as the scenario from which they are drawn. A number of cases can be made from one scenario. Several themes or perspectives can be demonstrated with one scenario that has been sliced into mini-cases which can each be reviewed in a short amount of time.

Mini-cases (which may be analogous to vignettes in military training) are also more manageable for the novice as the transition into intermediate learning is undertaken. Mini-cases allow small chunks of information to be studied without abstracting the information to the point that it is over-stylized and misrepresentative of the domain. Instead of moving from simple to complex information, complexity is first presented in small, cognitively manageable slices. This method of deconstructing the knowledge domain allows for a more flexible reconstruction of knowledge in new situations.

From a production standpoint, fewer cases need to be produced for courseware when a larger scenario can be decomposed into a number of vignettes that can be accessed from a number of perspectives, for example, to demonstrate many themes or principles. A lot of instruction can be derived from one scenario. Students are exposed to the complexity of a scenario and are also less likely to become lost while traversing the conceptual landscape when

the anchor of a single overall scenario is available. Resulting mini-cases are situated and provide contextualizing opportunities that will support generalization.

The application of Cognitive Flexibility Theory to advanced military training seems equally promising and difficult. Dick (1992) suggests that the Cognitive Flexibility Theory as described by Spiro et al. (1992a) is very complex in itself. Attempts to operationalize the concepts into courseware are definitely needed and will require careful study of this theory because it is packed with ideas. Not only will designers be required to carefully study the concepts of Cognitive Flexibility Theory to implement them, but they will also have to approach design differently in general than they addressed training efforts in the past.

Dick (1992) notes that the major difference between instructional designers generally working in the field and constructivist theorists is the emphasis by designers on the skills to be learned versus the constructivists' focus on the learning of a domain of knowledge. Designers typically identify skills and apply a hierarchical analysis to identify subskills supporting the terminal learning objectives or skills. Dick also highlights the concept from Cognitive Flexibility Theory that introductory learning may require the categorization of concepts, but later, more advanced learning of principles and problem solving requires a generalization of knowledge rather than a categorization.

This difference in learning strategies for novices and intermediates highlights two key points for consideration in design. One is that two different theories or strategies of instruction may be needed: one to teach introductory material and one to teach advanced material. Second, effective introductory instruction may actually be counterproductive to effective, advanced instruction. Effective categorization of skills and concepts in introductory instruction may interfere with the transfer needed to generalize concepts and skills across the domain of knowledge at advanced levels.

This author has seen a consistent pattern of this "training interference" in numerous exercises observed at the Warrior Preparation Center and the Battle Command Training Program. Both training experiences support unit training at higher levels (division and above). The authors of this report often gave leadership the feedback that battle staffs were observed focusing on the "close battle" to the exclusion of a holistic view of the battlefield. In discussions with Army leaders, the problems have often been traced to the detailed, skill-oriented training received and reinforced at lower echelons. Leaders must incorporate the lower level training into a new perception of problem solving to succeed over greater time spans and more geographical space.

Promising aspects of Cognitive Flexibility Theory application are seen in its seemingly inherent support of Force XXI training needs. *Force XXI Operations, TRADOC Pamphlet 525-5* (TRADOC, 1994) indicates the need for leadership to move to a more holistic view of the battlefield and a more flexible decision-making approach. Flexible means of combining knowledge within a domain has always produced an advantage. "...[S]uccess on past battlefields has resulted not so much from technological advances but from innovative ways of considering and combining available and sometimes new technologies as they apply to warfighting" (TRADOC, 1994, pp. 1-5). This skill is increasing in importance as the pace of change itself continues to accelerate the pace of change and the nature of operational commitments increases in ambiguity and unpredictability. "...[C]ommanders must apply principles and design considerations and frameworks in situations and scenarios we cannot predict with any certainty—truly a different demand on commanders than the relatively prescriptive and known scenarios of the Cold War" (p. 2-8).

Cognitive Flexibility Theory supports the overlapping of a number of concepts throughout the learning process to guard against compartmentalization of information which supports the Force XXI emphasis on nonhierarchical, dispersed operations and dispersed information sharing. However, in considering an implementation of this match in theory and training needs, we must recognize that there is a lack of empirical research to validate that the Cognitive Flexibility Theory predicts complex learning effectiveness and efficiency. Application of the theory to FAOAC would need to include a concomitant emphasis on assessment.

Model for Advanced Learning

Fire support performance was examined in this project from the perspective of current operational deficiencies and future operational challenges. This review has already defined the art of fire support as a complex, ill-structured domain, meaning that there is nonuniformity of explanation across the range of phenomena and irregularity of overlap in patterns across cases. Because situational patterns and applications of principles are difficult to predict, Cognitive Flexibility Theory recommends learning in a cognitively flexible manner to provide "...the ability to adaptively reassemble diverse elements of knowledge to fit the particular needs of a given understanding or problem-solving situation" (Spiro & Jehng, 1990, p. 169).

Continued increases in the complexity in the art of warfare are projected to come from the increase in tempo in a more complex battle space, with many simultaneous actions occurring, and from the unpredictability of situations, including scenarios outside Western paradigms of warfare

requiring rapid major reconceptualizations on the part of commanders and staff. The ability to cognitively process a wide diversity of situations and determine varying application of patterns of the principles and the ability to communicate will drive successful implementation of technology.

The following sections describe a learning model derived from the constructivist literature to address needs in advanced training and discuss considerations of using such a model.

The Student-Centered Learning Model

The student-centered learning process has been advocated for advanced training in Classroom XXI in the Army Distance Learning Plan. Only by supporting this process and providing an authentic context can we provide the period of sustained exploration needed for the advanced learner. To support the process, we first have to define it to inform training developers and instructors how to implement the approach. Figure 12 offers a learning model of this approach that shows specific actions. Training tools and methods can be designed to support each step of the process.

Figure 13 provides a categorization of the methods and media needed at each stage and level of training. The advanced learning stage would best be supported by a rich set of interconnected cases. Learning methods to support the use of such technology would be designed and implemented according to the learning model shown in Figure 12. The depiction of the student-centered learning model shows the actions of the student and the corresponding actions of the facilitator during instruction. Facilitation can be provided by a live instructor *or even carefully prepared feedback from automation, peers, and self-reflection.*

The Constructivist Instructional Design Process

The previous sections have described how constructivist instructional design and specifically, the Cognitive Flexibility Theory, are relevant to advanced military training to meet the current and projected needs. It is proposed here that application of these theories can produce more effective and more efficient advanced training than is currently available and can provide a rationale for the instructional technology that is used. Implications for training design are discussed in this section.

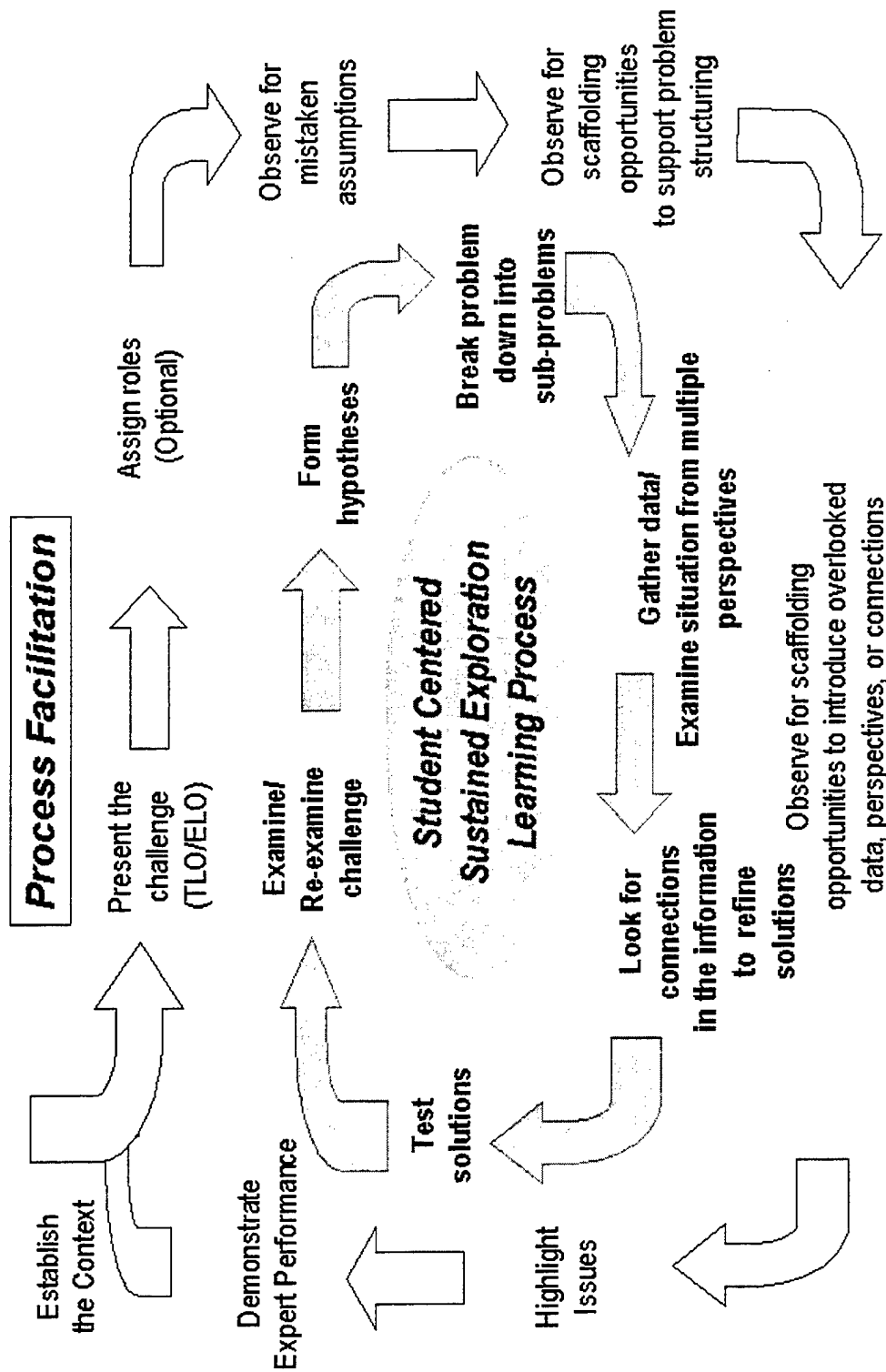


Figure 12. The student-centered learning model.

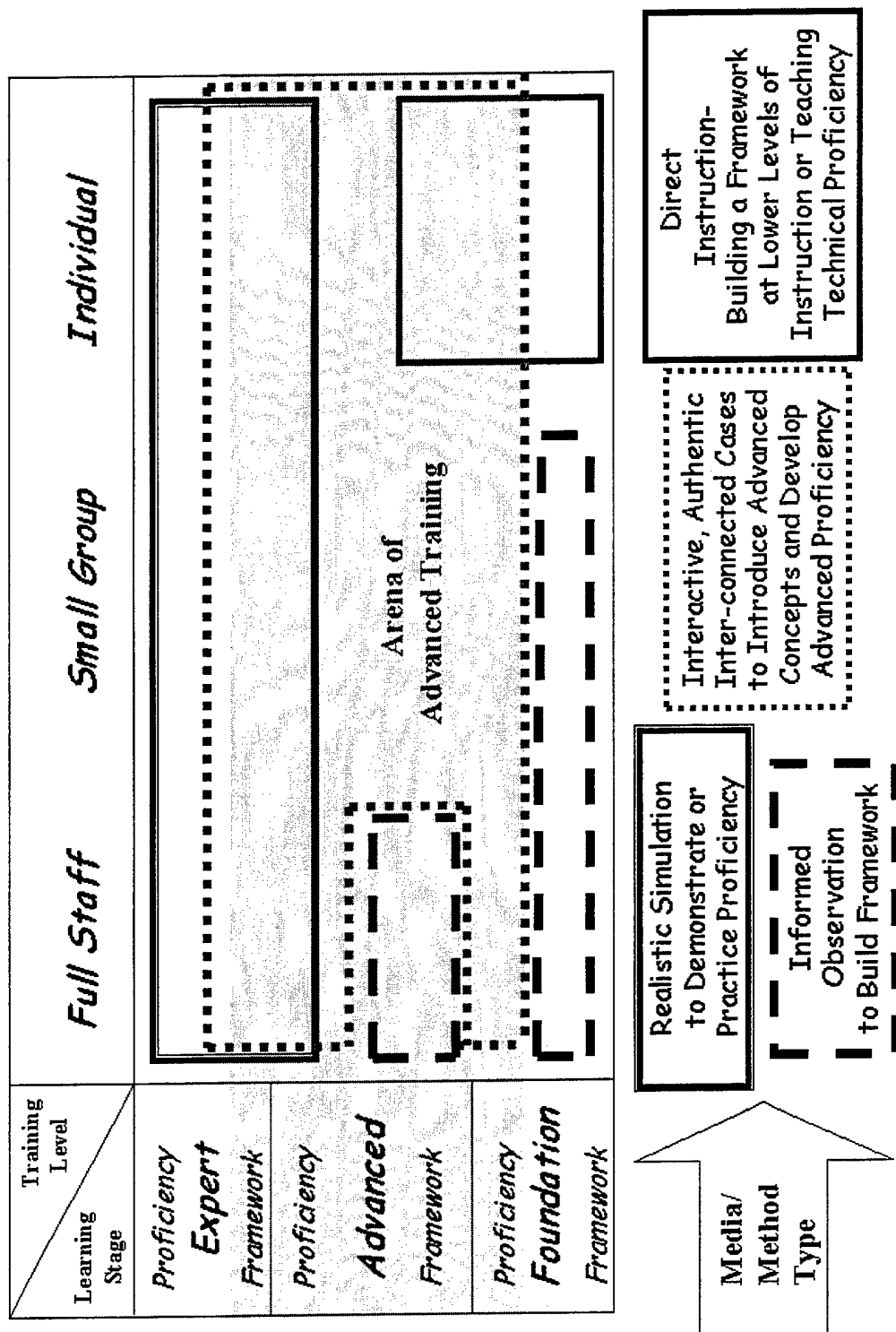


Figure 13. Learning objective and technology integration framework.

While constructivism can be described, it is very difficult to implement in a successful instructional design. Perkins (1992a) suggests that one way to understand the range of ways that various constructivists approach the design of learning situations is to contrast what he calls "BIG constructivism and WIG constructivism" (p. 49). BIG stands for "beyond the information given," and WIG stands for "without the information given." A BIG approach would directly introduce concepts and then provide opportunities for students to go beyond the introduction in refining their understanding. A WIG approach would refrain from direct instruction. Phenomena such as demonstrations might be introduced immediately and speculation invited before any principles are introduced or imposed on the learner. WIG instructors feel that learners must primarily rediscover the concepts to be learned. One might question whether constructivism is just another word for exploratory or discovery learning. An entirely WIG approach would seem to be completely exploratory and discovery oriented.

From this description, it would be easy to dismiss constructivist learning as purely inefficient, experiential discovery learning. However, the views espoused in this literature review do not propose pure discovery learning in an unstructured environment without goals. "In contrast to discovery learning, there is considerable guidance. It is simply not guidance in mastering a particular content element" (Bednar et al., 1992, p. 29). Assumptions about learning that structure a constructivist approach are not absent but rather are different from those underlying traditional ISD.

Constructivist design is inductive and supports student-centered learning. The learner is shown many examples and is supported in constructing an understanding of the basic principles involved and how they are interrelated. Instructivist design is, by contrast, deductive and directive. Rules and examples to support the rules are presented much more directly. Constructivism assumes that learning problem-solving processes in a particular domain within the context of complex problems is the goal. It presents the learners with concrete problems and encourages them to generate their own subproblems and hypotheses. The ISD process supports teaching the content of a domain and pre-specified procedures for uses of that content and assumes that the knowledge and procedures of a domain can be abstracted from the context of practice.

Constructivist and Cognitive Flexibility instructional design principles drawn from the literature are presented in Table 15 to better illustrate the approach. After their initial 3 years of experimentation with anchored macrocontexts, the CTGV (1993) makes the point that the well-designed macrocontext makes various activities possible but does not guarantee them. The

best learning activities are promoted by the design but are not automatic consequences of the design. Constructivist learning environments still require effective teaching. Implementation must support the teacher's role in coaching and providing scaffolding, collaboration, and embedded assessment to guide learning and the refinement of the design.

Table 15

Constructivist and Cognitive Flexibility Instructional Design Principles

Situated instruction (Cognition and Technology Group at Vanderbilt, 1992c)	Cognitive flexibility theory (Jacobson, 1994)
<ol style="list-style-type: none"> 1. Video-based presentation format (complex movies, not text, to support formation of mental models and more background detail) 2. Narrative format (a well-formed story as the learning context) 3. Generative learning format (story resolution must be provided by students; given resolution is not presented until students have worked their own) 4. Embedded data design (all the data needed to solve problems are in the video story and have to be identified and assembled by the student) 5. Problem complexity (a given problem may cause students to generate numerous interrelated steps and to consider multiple solutions) 6. Pairs of related stories (pairs support analysis across situations) 7. Links across content areas (such as the use of maneuver plan information to solve fire support problems) 	<ol style="list-style-type: none"> 1. Employment of rich cases and examples 2. Multiple forms of knowledge representation 3. Links between abstract concepts and cases 4. Demonstration of conceptual complexities and irregularities 5. Stress the inter-related and web-like structure of knowledge (use variable, not fixed, links in the hypermedia design) 6. Encourage knowledge assembly from different conceptual and case sources 7. Promote active learning

Excellent teaching requires preparation, not just subject matter expertise. One of the biggest challenges is for teachers to acknowledge their lack of expertise in some areas and to learn along with the students, to move through a lesson without a highly scripted lesson plan, and to understand the lesson from the learner's perspective. It is difficult for teachers to know *when* students really need guidance and when students are struggling in a constructive way. Teachers also need to know *how* to provide guidance that enables students. The CTGV goes so far as to

assert that “[i]n many cases, [ISD] seems to have been a response to the pragmatic reality of instructors with little or no teaching knowledge or expertise” (CTGV, 1992b, p. 115)

Scaffolding may be facilitated by the use of elements of surprise that engage students in a scenario and motivate them to make questions and assumptions overt. Procedures to assist students in formulating goals and in relating new information to known information are often necessary for novices. Such support can be “faded” at the learner’s discretion.

Instructor support for collaboration recognizes the social nature of cognition. A major goal of constructivist instruction is to help students develop socially acceptable systems for exploring ideas and differences of opinion and that these procedures may change over time (CTGV, 1992b). From the weaknesses cited in operational lessons learned, it is apparent that socially negotiated cognition is not as robust as it needs to be in the field.

Embedded assessment supports the concept of learning as “progressive restructuring” (Fosnot, 1992, p. 169). Assessment is not a matter of testing skills but of testing conceptual understanding. Feedback is needed in a form that allows the learner to challenge his or her assumptions and refine understanding. Errors are treated as opportunities for the systematic re-assessment of understanding.

“A major goal...is to create shared environments that permit sustained exploration by students and teachers and enable them to understand the kinds of problems and opportunities that experts...encounter and the knowledge that these experts use as tools” (p. 78). Designers should concentrate on the construction of the learning environment, not the construction of content-specific knowledge. The environments should include an abundance of tools to enhance communication and access to real-world examples and problems and to experts.

In conclusion, constructivist learning environments require thoughtful design and assessment, not just the availability of realistic case presentation or examination. Implementation requires instructor support and technological support. While some of these elements are missing from the current FAOAC simulation-based classrooms, a commitment has been made by the Army and USAFAS to create hypermedia, student-centered, case-based learning environments. Because of the substantial investment already made, it would seem prudent to fulfill all elements of the paradigm to create the likelihood of success.

IT'S NOT JUST THE TECHNOLOGY; IT'S WHAT YOU DO WITH IT

The field artillery vision for advanced institutional training is an intense, focused, motivating residential learning experience. Each student must arrive, ready to explore and solve realistic problems as part of a well-functioning group. A series of simulated practical exercises conducted over time within one complex, geographic and political scenario will provide the training environment. All technology introduced into the training environment must support that vision.

Augmenting Existing Strengths

Army training, with its emphasis on experience and "train as you plan to fight" perspective, has integrated some of the principles of constructivism. However, the implementation is incomplete. There are some missing pieces in the way advanced training is currently designed and executed.

While the Army strives for authentic training situations through the use of simulations in unit and institutional training, an opportunity to explore the rich context of a battlefield situation is often available only in high cost situations. Technology has not yet been used to introduce students to the complexity of cognition and collaboration in battlefield environments outside high cost training situations. In rich environments such as our CTCs, expectations for expert performance are high. These expectations limit the opportunities for sustained exploration of the environment that may be an appropriate learning mode for many "non-expert" training participants.

We are not supporting enough group problem solving in learning situations before we construct full scale, high cost simulations. We do not reinforce the absolutely essential tasks of communicating intentions, priorities, and capabilities. We do not provide low cost opportunities for training participants to explore situations from several perspectives and to develop an appreciation for the level of collaboration necessary for success. We rely on disjointed and abstracted cases instead of presenting rich situations. We need to provide challenges and guidance for trainees to work through complex situations and link lessons learned to context. Improvements in the use of simulations and operational lessons learned to structure problem-solving sessions for the advanced student and to structure observation of complex settings for novices would augment strengths already present in advanced military training, as would the use of technology to stimulate thinking skills before simulation training.

As the result of the FY 1997 CEP effort, we assert that we must use research and development to revitalize battle staff institutional training. This revitalization starts with further development of the theoretically derived learning model. It is not feasible for the development of innovative instruction or for the migration of current instruction to new techniques to be accomplished by the U.S. Army's current training developers. Training developers build instructional materials, based on a firm grasp of current methods derived from behavioral science. Innovation, and thus success, depends on the extrapolation of emerging learning theory to devise new design, development, and assessment methods. Developers are not behavioral scientists. Model products must be developed to extend and test theory, and developers must then be trained in new instructional design, not just in new media use.

Principles to Guide Technology Integration

The following principles are provided to guide the introduction and assessment of technology into advanced military training.

Deep Understanding of Concepts—Not Encyclopedic Learning

Training experiences are sometimes “a mile wide and an inch deep.” It is like trying to memorize an encyclopedia. The best the student can hope for is to skim the surface of a lot of information. Research has shown that when this training strategy is used for highly conceptual instruction, the result is inert knowledge, that is, knowledge that is recalled sluggishly or not at all when the learner is confronted with new situations or knowledge that the soldier cannot make available to interact with his or her perceptions of new situations to form solutions.

To make knowledge more active in performance after training (i.e., the soldier realizes what knowledge applies to a new situation and how to structure it in the new situation to solve problems), training experiences must promote a deep understanding of the principles or concepts underlying performance.

As Technology Changes the Way We Do Business, It Also Changes Our Goals for Education and Training

It is the individual's and organization's ability to use technology, not simply the presence of technology, that will make the performance difference. Given the ever-accelerating technological development that is becoming organic to human endeavors of all types, what will it mean to be educated or trained in 2020? Given our genuinely limited cognitive abilities, the way to keep pace with an ever-increasing pile of facts is to build a few theories of the right kind.

“...[W]e want to produce more theory builders, more synthesizers, more strategy inventors than fact managers” (diSessa, 1988, p. 44). Additionally, we need to consider that to be literate in a medium is not just to be able to absorb knowledge. We would not teach children to read and not to write. To use technology is likewise to compose as well as to “read.” “Hypercomposition...is a form of electronic composition that incorporates multiple forms of media: text, graphics, animation, sound, images, and video. Multiple forms of media facilitate multiple notational systems for ideas” (Lehrer, 1993, p. 200). Literacy in hypercomposition provides the ability to compose multiple layers of information and transforms information into a network rather than a linear structure allowing multiple orderings of information. Such literacy may become crucial when large amounts of information organized by themes or theories are managed.

The Advanced Learning Stage is the Unique Setting for the Development of Deep Learning

Development of a deep level of understanding during the advanced learning stage will aid soldiers in more fully exploiting later opportunities for expert practice that occur in resource-intensive unit training (such as at the CTCs). Deep changes in conceptualization are difficult to effect and need much time to develop. The advanced learning stage has unique processes and needs apart from those that occur in the novice or expert stages. To maximize training results, we must understand that the advanced learning stage

- is highly cognitive,
- requires the development of judgment and perspective,
- is a more complex and longer stage of learning than has previously been believed,
- requires sustained exploration of realistic problem situations, and
- requires multiple opportunities for feedback and reflection on the concepts

involved.

To Promote Deep Learning, Students Must be Provided With Intelligible and Effective Representative Tools of Thought and Communication to Construct and Externalize Their Mental Models

Taking the time to create deep learning in one area, rather than covering a large scope of material through pre-determined drills in a course, helps us to establish connections as we learn. Later, we can more easily find ways to access meaningful aspects of new situations and organize ideas to build solutions. When the student struggles with authentic problems for a period of time, the underlying concepts and data needed to solve the problems will become quite compelling information, which increases motivation. Activities must encourage students to pull information from resources as it is needed to solve problems and to construct their own idea of how the knowledge is inter-related. Technology can facilitate deep learning by providing rich,

realistic contexts for exploration and resources that help students and instructors display ideas as they are being developed. Learning to display one's understanding as it is developing enhances deeper learning, provides opportunities to develop true computer literacy, and provides a basis for collaborative understanding and problem solving.

Computer-Based Instructional Tools Must be Used in the Context of Collaboration

To fine-tune problem perception, hypothesis generation, and the gathering and processing of relevant information, students must negotiate the meaning and validity of their findings with others. This negotiation is a crucial battlefield skill. To succeed on the battlefield, a staff must build consensus or shared awareness of the situation and of options. They must be able to reflect together on their information-gathering and problem-solving processes. These skills must be practiced in advanced training settings before field exercise.

Prepare Students to Benefit From an Intense, Collaborative Residential Learning Experience

To benefit from the intense, active learning environment envisioned, students must be adequately prepared before entering that environment. To shift portions of advanced training from residence to distance requires the assistance of SMEs or instructors currently emerged in and observing students in the training process to achieve a quality product. Support must be also available during the residential portion of training for students to refresh their understanding of technical information and to overcome limits imposed by knowledge gaps in lower level skills.

Prepare Materials and Learning Environments for Individual, Small Group, and Full Staff Training Experiences

Training must be targeted to support individual, small group, or full-staff training levels, as well as the appropriate learning stage. Each training level builds a component of successful performance. The Janus simulation has been used in advanced training to simulate and stimulate full staff activities. We must concentrate on using simulations for small group instruction to bridge the gap between individual learning and practice as a full staff. Small groups of advanced students representing critical combinations of staff positions must be able to use a simulation to preview what works during the collaborative problem-solving process, not just to assess a final product.

Soldiers and Officers Expect Engaging, Challenging, Relevant Training

As institutional, unit, and self-development training begin to merge and overlap,

the pressure on the soldier to manage his or her own learning will increase. DL will force more of an emphasis on combining a full time assignment with ongoing study. Soldiers have a right to expect that their response to these increased demands will be met with training that is motivating and useful.

Target New Training Technology to Specific Learning Environments

Introduction of new technology that is viewed as having a potential to improve training must follow a process to integrate it into selected POIs—not just into physical locations.

Introduction of New Technology Includes a Plan for Assessment and Refinement

Introduction of new technology must include a plan for impact assessment and refinement that may include but is not limited to an experiment. Figure 14 provides an illustration of the central role of the guiding principles in technology integration. The principles are based on sound scientific theory and provide guidance for the design, development, and assessment of products developed or adapted for field artillery training. This iterative process leads to refinements of both the products and the principles.

Filling the Technology Gap: Proof-of-Principle Product Development

The priorities for short- and mid-term development are to

- create and maintain a shared awareness of the technology integration principles,
- create and maintain shared awareness of the developing U.S. Army training infrastructure,
 - define the products needed to implement the principles,
 - define the processes needed to ensure that the products are introduced and assessed according to the principles, and
 - create or adapt initial products that are *functional* examples of technology usage to illustrate and the learning model.

The priorities for long-term development are

- empirical validation of the training value added by the initial products,
- increased “hyperliteracy” among all players, which extends the concept of computer literacy, and
- definition and development of virtual environments.

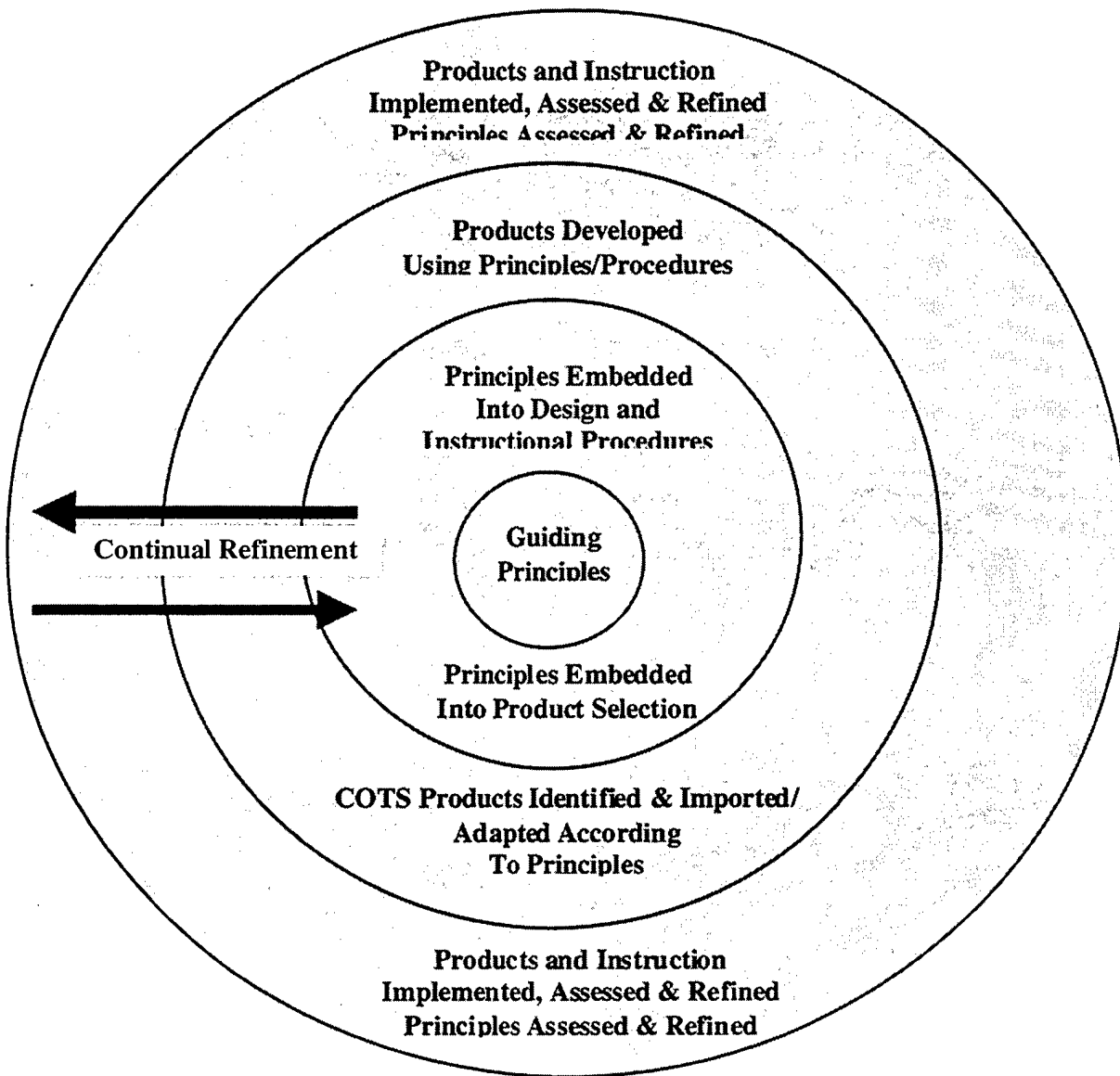


Figure 14. Technology introduction and refinement process.

Challenge 1: Bring the novice to the entry point of the Advanced Learning Stage so that he or she can benefit from a residential experience. Students coming into the advanced training experience are typically novices with a fairly good understanding of the military and some of the technical aspects of field artillery. However, their preparedness varies considerably. To benefit from the intense nature of the envisioned, residential component of training, the student must arrive with an understanding of field artillery fundamentals and an introductory understanding of advanced concepts.

Challenge 2: Create a coherent, residential learning experience. In the unit training environment, experts should be able to take advantage of what the resource-intensive training settings provide. In these high cost environments, practice at the expert level is the most appropriate use of simulation centers and combat training programs. Unfortunately, many professionals enter unit training, who have not been fully prepared to take advantage of these experiences. To enter this realm of expert practice, the soldier should ideally have a high level of proficiency in relevant individual staff skills and a considerable amount of experience in problem solving in both small staff groups and in full staff operations. The experience should ideally have been obtained in lower cost, advanced training situations. These situations should have allowed the soldier to experience sustained exploration of problem-solving processes.

A major task to support advanced field artillery training is the development of a coherent learning environment for the students during the residential portion of training. Residential training will eventually be restricted largely to compressed advanced courses, and it will center on practical exercises. A learning environment that can meet the projected residential training needs must be smoothly functioning and must integrate the tasks and the instructional approach with the media most appropriate for their support.

Challenge 3: Create processes supportive of continuous improvement. The ADLP provides an evolving infrastructure for Army training, but it is an enabling (not a prescriptive) infrastructure. TRADOC schools are expected to contribute to that infrastructure by facilitating local technology evolution in the classroom. The process calls for the identification of new technology, experimentation, refinement, and incorporation as new technologies become available. Many players (primarily instructors, students, ARL, D&SABL, and USAFAS) introduce technologies to the classroom. Coordination will ensure evolution and will maintain a vision.

Principles for Designing or Refining Initial Products

A synthesis of our literature review also resulted in a list of product design principles. These principles can be used to guide the specification of features in proof-of-principle products and to determine the desired “look and feel” of the products. The 13 principles are as follow:

1. Employ rich cases and examples in a narrative (story) format.
2. Embed multiple cases in a larger story (*macrocontext*) to sustain exploration across cases.
3. Use pictures, not text, to the extent possible.
4. Have the student provide “story” resolutions before he or she is exposed to “expert” solutions.

5. Embed the data needed to solve problems in the learning context.
6. Support multiple links between concepts across cases. Stress the web-like structure of knowledge across the domain. Use hyperlinks for random access of knowledge.
7. Present knowledge from multiple perspectives.
8. Stimulate the collaborative process by presenting problems so complex that students must work together to solve them, that is, students must socially negotiate problem solving.
9. Use active learning techniques. Students must do something; they must construct knowledge.
10. Support continual self-assessment, that is, self-reflection and articulation of the learning process by the student.
11. Provide support at critical junctures to push the student past current limitations, such as introducing information to correct persistent biases.
12. Expose students to expert performance.
13. Provide pairs of related stories to establish learning transfer outside the macrocontext.

Products for the Foundational Learning Stage

The foundational learning stage is characterized by

- initial entry into a domain of knowledge followed by
- competency and acquisition of proficiency in technical and procedural skills.

Training Level Learning Stage	<i>Full Staff</i>	<i>Small Group</i>	<i>Individual</i>
<i>Proficiency Foundation Framework</i>	<div style="border: 1px dashed black; padding: 5px;"> Interactive Case-Based Courseware <div style="border: 1px dashed black; padding: 5px; text-align: center;"> Informed Observation to Build Framework </div> </div>		<div style="border: 2px solid black; padding: 10px; text-align: center;"> Direct Instruction </div>

(extracted from Figure 13)

A proficient student leaving the foundational stage of learning often feels sure of himself or herself and has obtained an equilibrium only available to those who do not know what they do not know. Students currently arriving for advanced training courses at the USAFAS range from those who are at the beginning of foundational learning (rank novices) to those who

have obtained some proficiency at technical skills (foundational proficiency) and some who have started to understand the conceptual framework for the advanced stage of learning in field artillery and fire support.

Training products must be available to correct learning for students who are not yet firmly grounded at the foundational proficiency stage. Such products must constitute a blend of direct instruction of basic concepts and technical information and some opportunities to explore and construct one's own understanding of concepts and test the student's proficiency at the individual training level. Attention to conceptual and technical knowledge and comprehension deficits of such students will save money and effort in the long run when greater benefit is realized in the advanced training experience.

These products need to be exported as DL for students to work through or test from. The products would cover material that needs to be corrected from the Officer Basic Course and the content (excluding TRADOC Common Core) in the current fundamentals block in the FAOAC. The fundamentals block is currently the first portion of small group instruction. The products also need to be available on site during the residential phase of instruction for consultation by students who realize only later that there are gaps in the foundation of their learning.

Products would provide students with the common conceptual framework and terminology in use in the field and some opportunity to explore the field's concepts in realistic case studies or practical exercise. Direct instruction would be presented in self-study materials, which could be integrated with distantly accessed instructor feedback or built-in assessment functions.

Interactive case studies and examples would immediately follow the basic, direct instruction of the conceptual framework and terminology. Such cases would stress an understanding of roles, principles, and terminology across a number of examples, from a number of perspectives. Such individual staff training courseware could also be linked to produce a practical exercise among small groups of students. Interaction in full staff mode is not an appropriate mode of study for students who are not yet proficient in the foundation of the field.

Integration of automated feedback such as the use of "wizards" or "artificial intelligence" (in both direct instruction and case studies) would assist in reducing the need for instructor resources for distance feedback. Integration of voice-recognition software would simplify student interaction with the courseware.

A product is currently being imported to Fort Sill by ARL, which was identified in the Force XXI Army Training Program. It will provide some of the functions of the foundation products described. The product, called the Battle Staff Training System (BSTS), was released in 1998 and is an individual staff trainer providing assessment and diagnosis to teach the application of doctrine or TTP. There are 14 courses for 14 positions at the brigade level and 14 positions at the battalion level. The courseware consists of CDs and text and operates on a PC.

Exposure to expert performance is needed at all stages of learning. At the foundational stage of learning, exposure to expert performance can, however, leave the student confused and as uninformed as before exposure unless the student observation is structured. Techniques to structure observation are needed, especially as the Army training infrastructure begins to integrate unit, self-development, and institutional training by creating simulation links among schools and linking schools with CTCs for exercises.

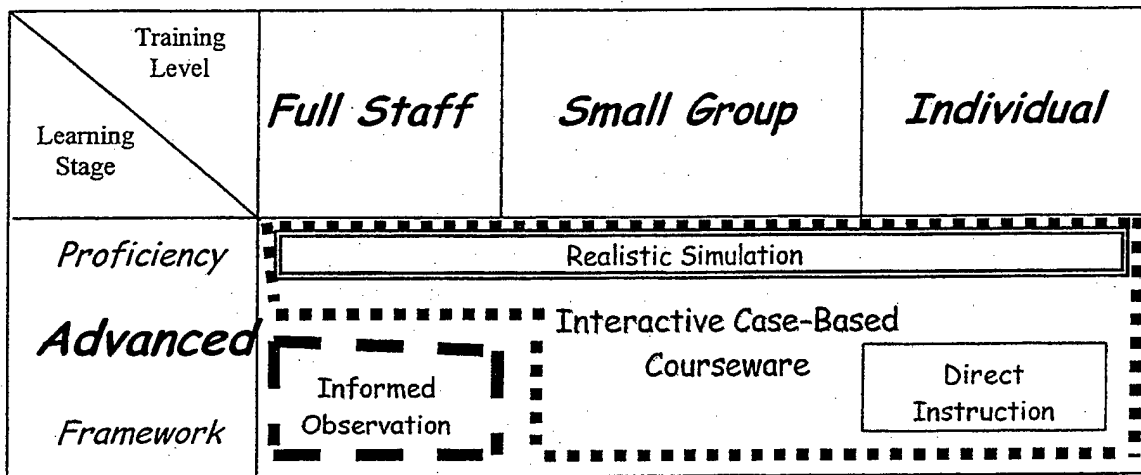
One example of structured exposure to expert performance was described by Shlechter and Anthony (1996). They examined the instructional value of demonstration tapes to support observational learning techniques. The tapes were used with 373 personnel from active and reserve or national guard armor platoon and company units. The tapes familiarized potential participants with both the SIMNET facility and the Virtual Training Program (VTP) and exposed the viewers to the modeling of expert performance in these training settings. Their use of video for structured observation is based on literature regarding cognitive apprenticeship (e.g., Collins, 1991; Collins, Brown, & Newman, 1989). Shlechter and Anthony (1996) concluded that "the effectiveness of any observational learning technique is dependent upon the effectiveness of its concomitant instructional program" (p. 13).

Products for the Advanced Learning Stage

The advanced learning stage (in this case, reflected in institutional training in the art of fire support) is the primary focus of this report. This stage of learning is the most complex and requires a rich mix of methods and media. This stage can benefit most from a consistent application of the constructivist instructional design principles.

Hearn and Swanson (in press) reviewed the instructional design theories underlying military training today and found that a widespread shift to such a cognitively based approach was evident in military research and development work. They also found that there has been little actual impact of this shift in training strategies in day-to-day training activities and products. Therefore, although the field of military training is recognizing the emerging need for

change in instructional design, few military training products or documented approaches exist to guide development. The shift in instructional design and development principles has emerged in training and education primarily to address failures in training transfer (CTGV, 1990). Such failures are particularly interesting to the military and industry since they are resource intensive.



(extracted from Figure 13)

The most efficient use of the residential learning environment would be facilitated by accepting new students who have a level of proficiency and a cognitive understanding of fire support that precluded very basic mistakes, misconceptions, and confusion that can be experienced by novices in a realistic, military practical exercise setting. If that challenge were successfully met through self-development and distance study, design issues for the second challenge (creation and use of a coherent learning environment for residential training) would be simplified somewhat.

The need for the availability of some individual, direct instruction materials to refresh foundational knowledge and procedures and to provide the framework for the advanced stage was discussed in the previous section. Material should be available before and during residential training. Direct instruction materials would provide “scaffolding” to the student during the demanding residential experience.

Informed observation techniques of full staff performance are also still desired in the beginning of the advanced stage. As the student progresses in the advanced stage, the ability to perform roles during full staff interaction increases and must then be supported by participation in vignettes designed for that purpose before and during the residential phase of training.

Current training methods treat the intermediate stage or advanced learning stage as a hurried leap from novice to expert, using overly directive instruction and comprehension level instruction to prepare students for immersion in a simulated warfighting environment. The use of a simulation such as Janus in a fully interactive, full staff mode provides opportunities for individual, small group, and full staff advanced proficiency demonstration and learning. However, successful use of Janus and other simulation technologies requires a different approach to student preparation than is currently used.

Design and development of interactive, vignette-based courseware for use before a highly intense residential course is recommended. This project has also yielded a high level design for such a proof-of-principle product. The product supports the development of Advanced Cognitive Understanding of Military ENvironments and is therefore called ACUMEN for its ability to develop keen insight and accurate and swift judgment on the battlefield.

ACUMEN is a cognitive learning tool students can use to monitor and diagnose their own learning and problem-solving performance across a number of vignettes within the setting of one richly complex battlefield scenario. One vignette template and one interactive module are being developed for proof of principle.

The implementation of ACUMEN is based on a constructivist approach. The interactive courseware could eventually be further developed and made available in a distance format that precedes a highly compressed residential phase. In the distance format, the facilitation role will ideally be implemented electronically through “wizards” or “artificial intelligence” capabilities to reduce instructor requirements.

As the interactive courseware is being developed and tested, research will be needed to assess the training product and the underlying theory. Research into such products differs somewhat from research traditionally associated with training, since a different paradigm of the learning process and expected outcomes underlies the product and the implementation (Jacobson, 1994; Jacobson & Spiro, 1994).

After students complete the proposed interrelated vignettes, introduction to highly compressed residential, small group instruction using realistic simulations should consist of orientation to the overarching scenario in which the student will work throughout the instruction. Students would be made aware of how to access instruction and reference material to fill any gaps that they perceived were not sufficiently covered in their pre-residence phase.

Orientation to the other tools in the learning environment (such as tactical equipment), the learning process, and the student responsibilities would follow.

Modified TSPs need to be developed for both the further development of the interactive courseware and the eventual, time-compressed residential training that mirror aspects of the TSP more often thought of as part of unit training. The traditional POI and media support plans will not adequately support the instructor and the student in the implementation of new learning processes.

Recent efforts by the Force XXI Training Program have highlighted the importance of the TSP for effective use of simulations. "Training support packages are the heart of the Force XXI Training Program" (Force XXI Training Program, 1998). The Army Research Institute (ARI) and the Force XXI Training Program have sponsored the development of a structured simulation-based training for three related programs to improve the Army's use of simulations. The term-structured simulation-based training is used here to refer to "...the deliberate design of training so that certain events will occur and cues will be provided to cause a specific training audience to perform particular (critical) tasks, subtasks, or actions" (Force XXI Training Program, 1998).

The three programs using their TSP development methods are

- COBRAS—brigade staff exercises and brigade staff vignettes;
- The VTP—exercises for platoons, companies, battalions, battalion staffs, and brigades; and
- Structured training for close combat tactical trainer (CCTT)—exercises for platoons, companies, and battalions using CCTT.

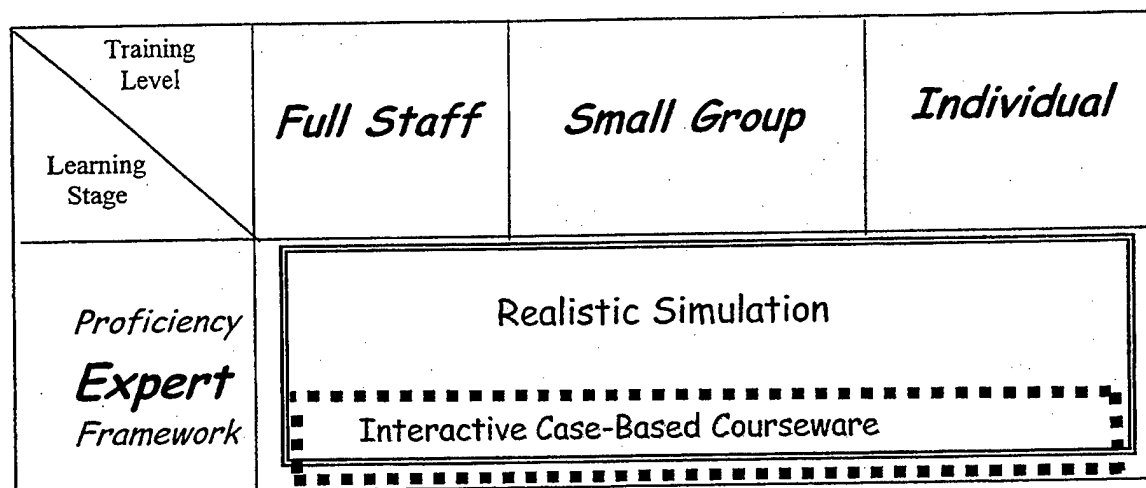
The process for developing the TSP for each program is most recently documented in Campbell and Deter (1997) and Campbell, Deter, and Quinkert (1997). Such a standardized approach needs to be considered for supporting the use of simulations at Fort Sill. The approach needs to be modified for use in developing interactive courseware, which is a precursor to full staff simulation-based institutional and unit training. While all aspects of the TSP methodology may not apply to the materials needed to support interactive courseware, the general need for describing the TSP requirements and the TSP production process exists.

As a set of training technologies is assembled for (a) training in the advanced stage of learning before engagement with a full staff simulation and (b) a coherent, time-compressed residential exercise experience, the long-term goal of a virtual environment classroom can be

addressed. The virtual environment classroom is the “Level 5” classroom within the Classroom XXI Master Plan (TRADOC, 1996b). No specifications exist yet for the virtual classroom, and only a few demonstration projects have been initiated. As with simulation technologies, the issues are much more pervasive than how to use one or more virtual technologies.

Products for the Expert Learning Stage

The expert learning stage is conceived as a function of practice in authentic situations with other highly proficient and knowledgeable individuals. Experts are able to provide their own structure for observation and feedback at the individual, small group, and full staff level. They may, however, select experts to implement that structure for them such as the observer or controller (O/C) role. Experts make little if any use of direct instruction in the form of knowledge mediated by an instructional developer. Vignettes may be used to introduce variations in principles and situations, but generally, the realistic simulation or actual practice (such as combat situations) are the settings for further development for the expert.



(extracted from Figure 13)

This report does not specifically address the expert stage of learning but acknowledges the intensive efforts of the U.S. Army and other military branches to develop realistic training settings. It is the primary purpose of this strategy to support the advanced stage of learning to prepare students to benefit from expert simulation environments. Tools developed for the advanced stage of learning may also have implications as job aids for experts and as self-development refresher material for units.

Other Products to Support Training and Development

Three other products are recommended to complete the strategy, and the need for more supporting products may emerge as the strategy is implemented. The three products described here are

- A software product to support the development of hyper-literacy;
- Web pages to support the development of hyper-literacy, increase collaborative interactions, and increase communications about training and performance issues;
- A technology-supported procedure for exchange of feedback among recent graduates, receiving units, and current instructors and students.

The first product supports the creation of hyper-literacy for instructors, students, developers, and researchers. It will also allow them to preview more of the anticipated Classroom XXI capabilities and the 21st century classroom culture. Hyper-literacy is used here to refer to the ability to compose in hypermedia, as opposed to the ability to simply view and interact with the compositions or products of a select few computer and training development specialists.

Throne and Lickteig (1997) recently published a review of the literature in the acquisition and retention of computer skills. They maintain that since the U.S. Army's force modernization plan assumes information dominance that depends on the exploitation of advanced technologies, "the nation's defense will progressively rely on the computer-based skills of its leaders, soldiers, and civilians...Army training must successfully address the acquisition, retention, and transfer of computer skills" (p. 1).

The position of our technology integration strategy is to take this assertion one step further. "Computer literacy' is a bad joke without a good body of 'literature,' without the sense that it is essential to be able to express one's self in the medium." If we cannot make tools accessible, computers will fail as an intellectual medium: "never a true medium..., but only a meta-medium, reserved for experts" (diSessa, 1988, p. 61). Until recently, computer literacy was somewhat one dimensional because most people other than experts were literate in one or two specific programs or work systems. As we have expanded access to multimedia and high speed computers, we must expand our definition of computer literacy to include the ability to express one's understanding of the external world through computer media, and not just the ability to mediate a work process. Such general literacy will assist in the ability to work with a range of computer media. This ability will both obviate the known perishability of application-specific

skills and increase individual ability to express complex ideas in multimedia to compensate for increased information load.

Throne and Lickteig (1997) concluded from their review of the literature that

- guided exploration improves computer skill acquisition more than just reading a manual,
- active participation increases learning,
- skills training based on a problem-solving strategy may slow acquisition but increase retention, and
- concrete models such as the desktop metaphor may improve skill acquisition.

Such conclusions support the constructivist training approach recommended in this document not only for training in the fire support domain but for training in computer literacy. We propose the development of a software tool (using the same principles as devised for training product development) to guide the researcher, student, instructor, and developer to achieve literacy with multimedia. Some developers may object to the need for multimedia literacy for a SME, citing dangers of non-developers creating and implementing training materials. However, SMEs are already doing so in classrooms every day; other TRADOC schools are providing more access to high level skills for their SMEs; and industry recognizes the SME as the fastest growing segment of training developers. Industry reflects their recognition of wider spread needs for multimedia literacy in their current development of “user friendly” courseware authoring tools for the SME and occasional developer.

We are calling our proposed tool the Personal Instruction and Learning Orientation Tool (PILOT). The tool will offer the user easier access to a world of tools for supporting his or her learning and instructional needs. PILOT is envisioned as a “meta-tool,” that is, a tool to increase general ability to compose in hypermedia, not just a tutorial of specific software packages.

The second training and literacy support tool planned is a web site to support the various users involved in the FAOAC. The web pages are being designed as a “collaborative work palette.” The purpose of the web pages is to provide a useful place for gathering field artillery and course information, discussing issues, generating new ideas, and accessing new tools for teaching and learning.

The third tool is technology support for feedback from the field concerning performance by graduates of advanced training. Regular discourse between the field and current

instructors, specifically regarding training needs, is currently lacking in the development cycle for advanced training. A standardized survey, an issues forum, or other format could be integrated into the web site or formally distributed on line at regular intervals.

Technology Introduction and Assessment Processes

Successful technology transfer depends on three intertwined processes: an external process to identify new technologies, an organizational process to identify technological needs and review and implement potential solutions, and an assessment process to ensure that goals and principles are well formed and are being met.

External Process—Technology Monitoring

Currently, ARL and D&SABL identify and import new technologies for institutional and unit training and combat performance. In the training arena, USAFAS training developers are primarily interested in training for lower level technical skills at this time. They have asked D&SABL to focus on technology for higher skill levels. This external technology identification process has been successful.

Efforts have resulted in the

- integration of stand-alone simulation capabilities in the experimental classrooms,
- the provision of the Janus battle simulation to support course training exercises, and
- the current development of the advanced experimental environment (AEE) (a variation of the ALE), as a visualization environment to integrate more realistic planning, rehearsal, and AAR activities into training.

This CEP effort has added a component to the technology identification capabilities. That component is an ongoing review of advances in training development and implementation products in industry and academia.

Internal Organizational Process—Defining Success

The integration of new technology will be more successful if an organizational process is established to communicate regarding new technologies and their potential implementation. When a new technology is identified, potential users or test participants should be involved in a “front end analysis.” This analysis would be used to determine how a functional implementation could best be constructed, given D&SABL’s and ARL’s understanding of new technology and the user’s understanding of his or her environment.

For example, if a new technology is identified that is believed to be of use for both the Officer Basic Course and FAOAC, a representative or liaison should be included in the acquisition and demonstration planning. Such an integrated project team would provide the best resources for selecting potential users and a demonstration scenario. The use of the team approach will ensure that a new technology is linked to a specific portion of a POI or other training event. No technology will be introduced without a clear concept of how it can potentially be used. All technology introduced will have a planned functional capacity and committed users available to serve as a test bed for assessment efforts.

Refinement Process

Our analysis of FAOAC in FY 1997 showed that without the kind of processes proposed here, little is accomplished when new technology is introduced. The experiment to compare the classrooms with and without advanced technology indicated that there was no effect of technology on the learning process or outcomes. Without implementation of the three intertwined processes, opportunity is also lost for assessment of the impact that can guide future acquisitions.

“In many cases, the design and building of computer-based instructional systems provide the occasion for fundamental theoretical examination” (Resnick & Johnson, 1988). Because this strategy is based on theory and research in instructional design, it is important to design assessments or experiments that examine the impact of imported or newly developed technology and the underlying learning and product design principles.

The Battlefield-Relevant Instructional Design Guidance Environment (BRIDGE)

As a practical realization of this strategy, a hypermedia laboratory was developed to serve as a focal point for integrating new technology for advanced institutional training. The vision is for the instructional strategy to be embedded into this hypermedia environment. This laboratory is called the battlefield-relevant instructional design guidance environment or BRIDGE. From this environment, researchers, developers, instructors and students can navigate in 21st century learning environments.

Efforts in the BRIDGE will produce experimental proof-of-concept courseware, the proposed PILOT software, and other tools to support advanced training such as the proposed web site. The BRIDGE is more than a multimedia lab; it is a concept that includes locating a portion of the BRIDGE resources in the FAOAC instructors' work area across Fort Sill,

Oklahoma. These resources provide a high access technology situation for the instructors, and we plan to document how instructional innovations emerge in such a high access environments.

The BRIDGE will serve as a place for collaboration to develop other ideas for the evolution of Classroom XXI at the USAFAS and as a focal point for refinement of this model of technology integration. The BRIDGE will be used to develop, adapt, and transfer cutting edge technology and instructional theory to the classroom to fully realize the goal of creating 21st century students, instructors, and learning environments.

CONCLUSION

Advanced training conducted in the FAOAC was the focus of study in this CEP. Most of the FAOAC small group instruction training objectives were found to be of a highly cognitive nature. They are correctly characterized as the art of fire support. Currently, these training objectives are taught along with a number of more fundamental objectives in a residential setting. Several forces are coming together at once, which impact the future of that arrangement. These forces are

- The need to standardize advanced training across active, guard, and reserve components.
- The need to limit expensive residential training and the growing possibility that if training can be raised to meet the standard and administered at a distance for reserve and guard components, the same can be done for the active component.
- The need for continued improvements in simulation technology and the ability to distribute them over wide geographical areas.
- The umbrella efforts of the ADLP to facilitate training re-engineering by creating a highly technical instructional platform to serve Army-wide training.
- Force XXI philosophy directing the Army to maximize information technology on the battlefield.
- Advances in information technologies that create new learning and communication goals across a number of human endeavors.
- Advances in instructional technology and theory that make new learning processes that mirror the learner's cognitive processes more closely than ever.

To exploit these various forces and use them to bridge the way to future enhanced performance requires a strategy. The results of this CEP demonstrate that the introduction of new technology into the training process without a strategy does not improve the learning process or outcomes. The literature provides us with an alternate approach by providing theory and some evidence regarding the most effective instructional approach for advanced training and how technology can support that approach. Implementation of emerging theory will be challenging since few models are available, and the theory somewhat opposes the traditional

military training development process. Yet, training in simulation environments throughout the military has been moving toward this new paradigm in advanced training for some time without fully articulating an underlying learning model. To maximize this training evolution, we must complete the picture by fully articulating the theoretical underpinnings and using them to guide and assess development decisions and technology implementation procedures.

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APPENDIX A

CURRENT INITIATIVES TO RE-ENGINEER ARMY TRAINING

CURRENT INITIATIVES TO RE-ENGINEER ARMY TRAINING

Army-wide Initiatives

Several interrelated projects are under way, which impact the short, mid, and long-term plans for Classroom XXI and FAOAC at Fort Sill, Oklahoma. The overall context for change is presented in the U.S. ADLP (U.S. Army Training and Doctrine Command [TRADOC], 1996a). The ADLP is a programming document. "Its purpose is to identify the processes, products, infrastructure, hardware, and personnel support needed to implement a total Army DL program. It provides the basis for developing input to the program objective memorandum (POM) for FYs 1998 through 2003 and the extended planning period (EPP), 2003 through 2010" (p. iv). *The plan establishes a technology baseline but is predicated on integrating new technologies as they become available. Each major Army command (MACOM) and proponent school is responsible for preparing individual command implementation plans.*

The ADLP supports Force XXI, the Army's view of the future that restructures the Army around information technological capabilities to best implement the U.S. national military strategy. Army Training XXI (AT XXI) is the Army's strategy for training the force to operate in the Army of the future. The three traditional training pillars of the Army (institutional, unit, and self-development) will eventually merge as the plan unfolds, placing a greater responsibility on unit and self-development. WARRIOR XXI is the institutional and self-development component of AT XXI as illustrated in Figure A-1 (TRADOC, 1996a, p. 1-3).

There are eight major WARRIOR XXI initiatives:

- The total Army school system (TASS)
- Clusters and satellites
- Classroom XXI
- Distance learning
- Automation and digitization
- Training development revitalization
- Diagnostics
- Advanced training strategies, including on-demand training and mission rehearsals

The ADLP helps support the translation of concepts into reality across the AT XXI strategy through the implementation of DL applications. The plan also outlines the process for providing the basic classroom training capabilities.

Classroom XXI opens learning to students worldwide. It includes the facility upgrades to TRADOC institutions, local area and campus area networks, and necessary equipment to capitalize on distance learning, distributed interactive simulations (DIS), and other training modernization initiatives designed to provide an institutional learning environment with worldwide scope. Funding in the form of key enabling investments (KEIs) has been identified to improve the distance learning infrastructure at selected TRADOC institutions and to begin reconfiguration of high priority courses for distance learning presentation. (TRADOC, 1996a, p. 2-9).

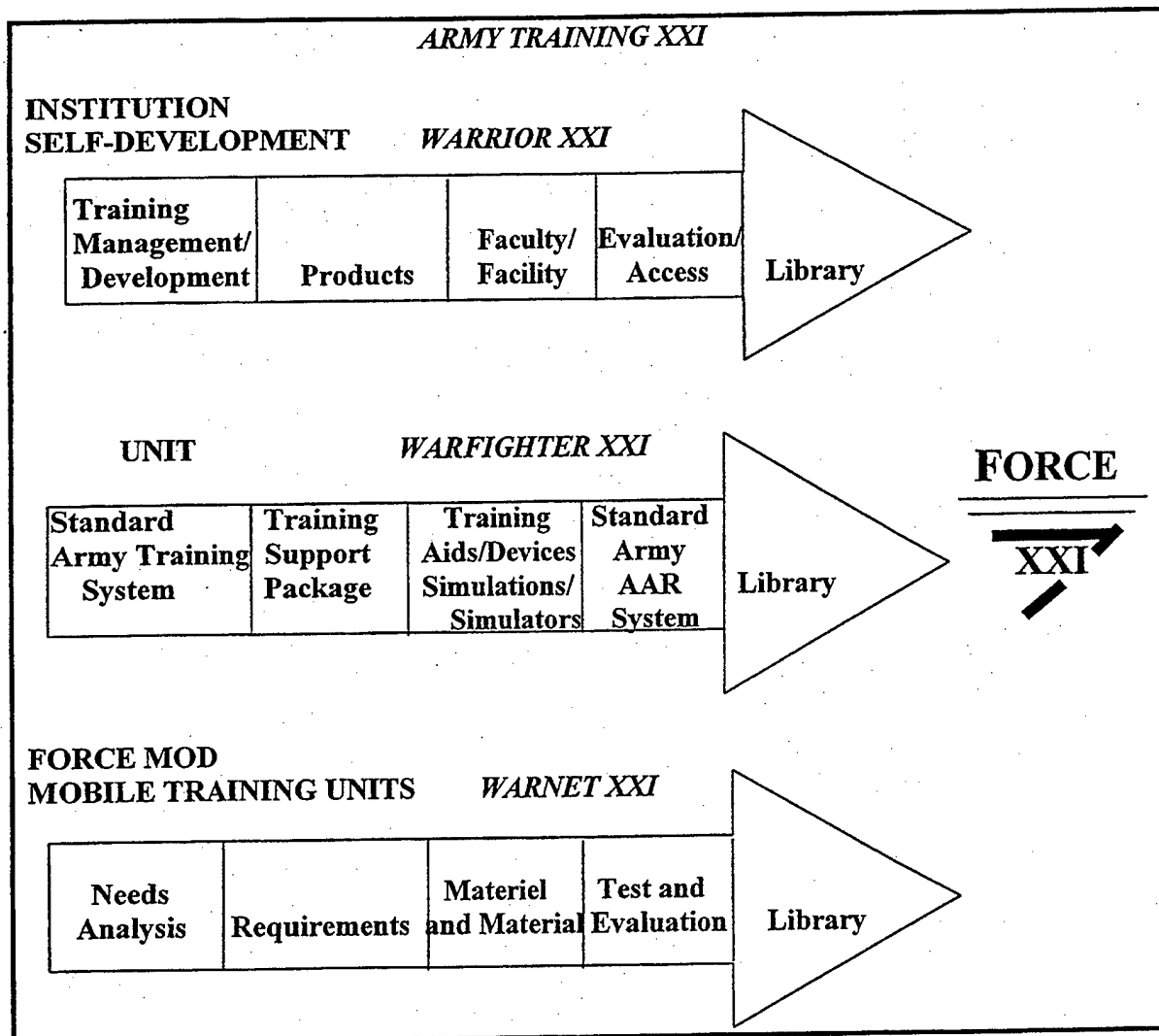


Figure A-1. Army Training XXI (U.S. Army TRADOC, 1996a, p. 1-3).

KEIs and POM funding for Classroom XXI (and other AT XXI instructional technologies) will expedite acquisition of modern training technology. "These investments will provide the foundation upon which *training re-engineering* (emphasis added) is based. TRADOC's goal is to incorporate current media, as appropriate..., and future media as available, into a single hypermedia high-tech instructional platform" (TRADOC, 1996a, p. 2-11). There will be a constant evolution in which instructional technologies are adopted and replaced as this goal is pursued.

The term hypermedia refers to recent advances in which computing and communication technologies are combined to make flexible connections between formerly distinct media. Hypermedia systems facilitate flexible restructuring of instructional presentation sequences, multiple data coding, and multiple linkages among content items, and they provide for uses of the

material that cannot all be anticipated during the design but will evolve as the learner's understanding evolves.

The TRADOC Classroom XXI KEIs provide for the enhancement of the infrastructure of installations and schools that started in FY 1995 to support Classroom XXI initiatives. The KEIs support the upgrade and expansion of communication and computer networks. KEIs were planned to provide the technology support center and two classrooms for DL facilities at selected TRADOC installations. Fort Sill was one of the installations selected to receive funding for two high-level classrooms and a technology support center. The two classrooms, which are becoming Level 4 classrooms, are to have interactive simulation capability, specifically the Janus simulation. The FAOAC course was targeted for incorporation of the simulation into training. The ADLP envisions that the simulation will eventually be linked to Fort Benning, Fort Bliss, Fort Knox, and Fort Rucker.

At this time, Fort Sill has eight classrooms in Snow Hall, which have been modernized to some extent. They are targeted as six Level 1 classrooms and two Level 4 classrooms, although the complete integration of technology into the classrooms is still emerging. Classrooms are targeted in the ADLP to support specific courses. At this time, FAOAC is the primary recipient of the modernization to Level 4 at Fort Sill. The components of Levels 1 – 5 classrooms are explained in Figure A-2 (TRADOC, 1996b). As the level of the classroom progresses, the emphasis on student-centered learning is greater. Figure 3 from the Classroom XXI Master Plan (TRADOC, 1996b, p. 3) provides an overview of the projected classroom capabilities.

Level 1 classrooms are the first rung of the ladder of training technology. This level is the least expensive. It supports training that is instructor based. The instructor is the focal point, and he or she controls training from a multimedia instructor workstation. Types of equipment are

- Multimedia instructor workstation
- Videotape and commercial cable TV
- Integrated projection system
- 3-D visual presentation system

Level 2 classrooms start the movement to student-centered training. At this level, students have individual multimedia workstations and are connected to a classroom local area network (LAN). The instructor moderates instruction as a SME. In addition to Level 1 equipment, Level 2 contains

- Student multimedia workstations
- Student-instructor multimedia workstations on classroom LAN
- Video on demand
- Automated student response system integrated into the workstation

Level 3 classrooms provide both the student and instructor electronic connection beyond the classroom and school and therefore enter the DL arena. The student and instructor can participate in off-site training. The student is the center of the training process through active

participation. The Level 3 classrooms contain Levels 1 and 2 equipment and the following technology:

- Internet access
- Video tele-training (2-way audio and video)
- Interactive multi-point whiteboards

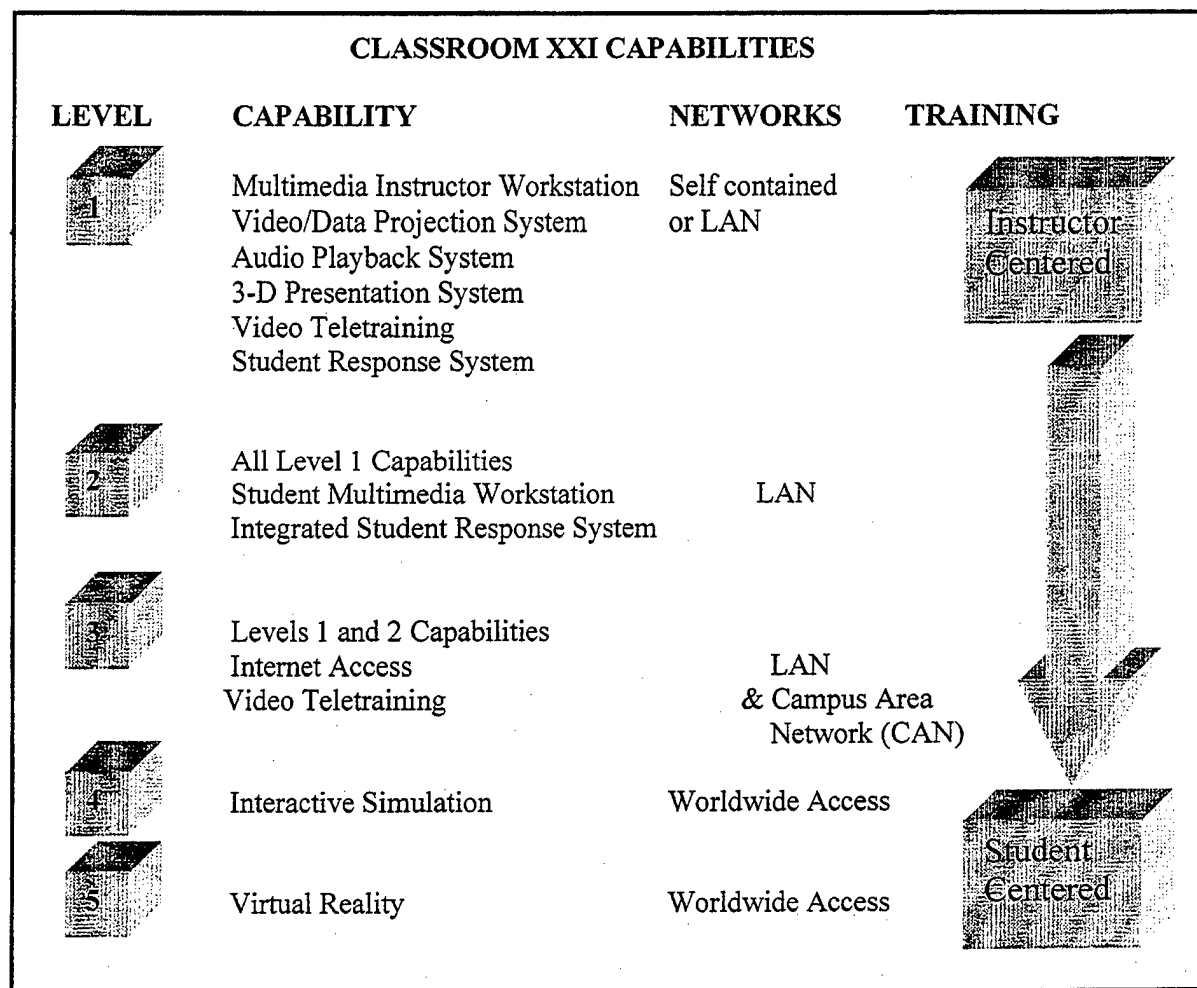


Figure A-2. Classroom XXI capabilities (TRADOC, 1996b, p. 3).

Level 4 classrooms will provide the natural evolution to DIS. Students can participate in a wide variety of simulated exercises. Instructors become observer-controllers who facilitate exercises. The classroom will contain the equipment just listed and an interactive simulation.

Level 5 classrooms would be based on a virtual reality environment. While there are some experiments under way to define this environment, TRADOC plans do not specifically address the Level 5 classroom at this time.

Although the primary benefit expected from training improvements is increased readiness, a key component motivating change in schoolhouse training is the potential cost savings. Reduction in the number of instructors or reductions in total instructor time and student time are also significant desirable features of change in training media and methods. A cost analysis is presented in the ADLP (TRADOC, 1996a), for example, but no similar analysis is presented in the Classroom XXI Master Plan (TRADOC, 1996b). Costs identified in the ADLP pertain to the savings obtained when students are not in residence (e.g., per diem, travel, and permanent change of station when the original course is longer than 20 weeks) and savings in costs of using traditional instructional support (e.g., reduction in the leasing of Satellite Education Network and U.S. Army Tele-training Network, video teleconferencing telephone fees, instructor training costs, and TRADOC installation base operations). An additional expected effect is that a higher number of students will be reached, thus eliminating a backlog of soldiers who are currently not qualified in a specialty area.

The effectiveness of the training process using DL and Classroom XXI technology is assumed to be as good if not better than current traditional self-development and institutional training. Although there are no data to substantiate that the new training infrastructure will be of at least equivalent effectiveness, that hypothesis was accepted for the purposes of cost analysis.

The projected savings are substantial—\$857 million over the period 1998 through 2010 for training that would take place, \$46.5 million savings over the same period for training the backlog of unqualified soldiers through DL rather than residential training, and a \$113.5 million offset in initial costs through investments being made by others (Classroom XXI KEIs, training development, and National Guard efforts). Initial investments to establish 197 facilities are projected to be \$103 million for the infrastructure, \$205.8 million for implementation of the 197 sites and around \$1 billion for courseware conversion to multimedia for 698 courses. A total cost projection is not shown in the ADLP, but it appears that total funding projections will be around \$1.309 billion, and this will be offset by savings of \$1.017 billion. Once 2010 capabilities are reached, the ADLP projects that \$91 million per year can be saved by training today's equivalent soldiers with the new system. A substantial investment and rapid conversion in the coming years will set the stage for greatly improved training from a fiscal perspective and increased performance for future operations.

Fort Sill Initiatives

In 1997, Fort Sill received \$494,000 specifically for distance learning technology and \$2.5 million for classroom improvement (MG Rigby, as cited in Hill, 1997). The WIDD at Fort Sill is responsible for developing the DL plans and the Classroom XXI plans specific to Fort Sill. Their current ambitious plan projects a rapid conversion of much of the technical skills training currently accomplished at Fort Sill to DL. The strategy is to reduce resident learning for all but officer and NCO courses first. The residential time of these courses will also be reduced later.

A Fort Sill working group is developing plans to greatly reduce the residential time for the FAOAC as part of TRADOC's Captains' professional military education project (CPT PME). TRADOC's CPT PME action plan (TRADOC, 1997) "describes the architecture, identifies

actions, assigns responsibilities, and establishes milestones to complete the transition from the current two-course Captains' professional education to a single Captains' career course" (p.1). The Captains' career course merges current officer advanced courses and the Combined Arms and Services Staff School course (CAS³).

A phased approach would reduce hours for the FAOAC each fiscal year. Eighty hours will be cut from the course in FY 1999. The local working group is selecting the areas in which the course will be reduced or rearranged to accomplish the reduction of hours and eventual integration of CAS³.

A working group in WIDD conducted a prescribed Army training analysis and process on the FAOAC during the fourth quarter of FY97 to determine how the course should best be modularized, how much of the course can be exported to DL, and what media formats should be used. This work is continuing at the time of this report, and findings from this study will be integrated with the working group's findings as appropriate.

In addition, the small group instructors for FAOAC were asked by the Assistant Commandant, Fort Sill, in April 1997, for their recommendations to modernize the FAOAC media and methods. Their recommendations were to (a) move toward further integration of the interactive simulation and as much of the virtual environment as is feasible, (b) cut the small group instruction to only 6 weeks eventually by using simulations for realistic task performance of the "art" of fire support, (c) reduce and integrate the CAS³ course entirely within FAOAC with the first week of FAOAC being devoted to briefing instruction and problem-solving exercises, and (d) do these things faster than the current overarching plans call for.

D&SABL at Fort Sill develops initiatives for the integration of advanced technology into fire support training at the USAFAS. One D&SABL initiative in particular affected the FAOAC in FY 1998. D&SABL has obtained an ALE which became operational in FY 1998. (This procurement is one of the KEI initiatives referred to before.) The ALE is being implemented as the AEE at D&SABL. It can form the basis for augmenting the interactive simulation in the Level 4 classrooms and for moving to elements of a virtual reality environment by providing superior battlefield visualization support.

Clearly, the evolution of the classrooms and the evolution of officer training at Fort Sill are impacted by many factors and opportunities. Integration of new technologies and processes is happening so quickly that impacts will be difficult to assess. While overarching TRADOC plans guide the general infrastructure of the FAOAC and Classroom XXI evolution, local responsibility will entail much experimentation with specific media and methods for the training that will remain in residence, in addition to decisions about what tasks to export and how.

APPENDIX B

LIST OF 37 TERMINAL LEARNING OBJECTIVES
IN SMALL GROUP INSTRUCTION

LIST OF 37 TERMINAL LEARNING OBJECTIVES IN SMALL GROUP INSTRUCTION

(Note. Two-letter designations in parentheses following each TLO are task identifiers assigned by the Field Artillery School. They are not abbreviations or acronyms.)

- | | |
|---|---|
| 1 Fire Support TLO: (CA) | Given a task force operations order, apply troop leading procedures at company or team level.
(Defensive PE) |
| 2 Fire Support TLO: (CE) | Given a heavy or light organization, explain the positions and functions of the FSE from company to corps. |
| 3 Fire Support TLO: (CF) | Given a tactical situation, apply the top-down fire planning process. |
| 4 Fire Support TLO: (CG) | Given a tactical scenario, maneuver CDR's concept of the operation, fire support assets available, and input from FSE representatives, develop and rehearse a fire support plan. |
| 5 Fire Support TLO: (CH) | Given a tactical scenario, recommend mortar employment at company and battalion level in Army and USMC units. |
| 6 Fire Support TLO: (CL) | Given a tactical scenario, recommend the employment of fire support assets in a heavy defensive operation. |
| 7 Fire Support TLO: (CM) | Given a tactical scenario, plan the employment of special munitions. |
| 8 Fire Support TLO:(CN) | Given a brigade or higher OPLAN or OPORD, apply the tactical decision-making process (TDMP) to develop and recommend COAs, and write an appropriate OPLAN or OPORD. |
| 9 Fire Support TLO: (DG) | Given a tactical scenario, apply the U.S. Army doctrine in defensive operations. |
| 10 Fire Support TLO: (EB) | Given a brigade defensive OPORD, develop a TF OPORD using the TDMP practical exercise (PE). |
| 11 Fire Support TLO: (FF) | Given a brigade offensive OPORD, develop a TF OPORD using the TDMP PE. |
| 12 Fire Support TLO: (FI) | Given a tactical scenario, apply the U.S. Army's operations doctrine in offensive operations. |
| 13 Fire Support TLO: (GE) | Given a tactical scenario, advise the maneuver commander about the employment of COLTs and aerial fire support teams (AFSTs). |
| 14 Fire Support TLO: (ID) | Given a tactical scenario, recommend the employment of FS in offensive operations. |
| 15 Fire Support TLO: (MC) | Given a brigade fragmentary order (FRAGO) for movement to contact, develop an order and a quick fire plan. |
| 16 Fire Support TLO:
(TNWC) Classified | Discuss special munitions systems, their effects on target and fratricide potential. At a minimum, include MLRS family of munitions (MFOMS), smart and brilliant munitions, family of scatterable mines (FASCAM), and smoke. |

17 Field Artillery TLO: (AETA)	Given a tactical scenario, advise the commander about the employment of TA assets, including firefinder radar, survey, and meteorological data systems.
18 Field Artillery TLO: (AR)	Given a tactical scenario, develop the FA organization for combat in accordance with (IAW) FM 6-20.
19 Field Artillery TLO: (GG)	Given a tactical scenario, coordinate the operations of DIVARTY and FA brigade operations centers.
20 Field Artillery TLO: (GH)	Given a tactical scenario, prepare a schedule of fires.
21 Field Artillery TLO: (GJ)	Given a tactical scenario, perform target value analysis in accordance with FM 6-20-10/40.
22 Field Artillery TLO: (GK)	Given a tactical scenario, produce a field artillery support plan (FASP).
23 Field Artillery TLO: (GL)	Given an offensive scenario, develop a FASP and conduct target value analysis.
24 Field Artillery TLO: (HE)	Given a tactical scenario, plan the employment of a field artillery battalion.
25 Field Artillery TLO: (HF)	Given a tactical situation, plan the logistics for a field artillery battalion.
26 Field Artillery TLO: (HQ)	Given a tactical scenario, compute the ammunition required supply rate (RSR).
27 Field Artillery TLO: (HR)	Given a defensive scenario, organize field artillery units for combat, develop a FASP, and conduct target value analysis.
28 Field Artillery TLO: (IB)	Given a tactical scenario, plan a convoy for an FA unit.
29 Field Artillery TLO: (KD)	Identify RSOP requirements peculiar to urban terrain, which enhance survivability and sustainability.
30 Field Artillery TLO: (KE)	Given a tactical scenario, recommend survivability techniques for FA units IAW FM 6-20-1.
31 Field Artillery TLO: (TNMS)	Given a tactical situation, describe nuclear, biological, and chemical operations in the battery defense.
32 Joint Applications TLO: (AP)	Given a tactical situation, identify the missions, tactical organizations, and employment options of Fleet Marine Force, including the fire support structure IAW FMFRP 2-12.
33 Joint Applications TLO: (AW)	Given a tactical scenario, plan fires to support AASLT operations, including an artillery AASLT.
34 Joint Applications TLO: (FD)	Given a tactical situation, develop a military operations on urban terrain (MOUT) fire support plan and plan bn or btry movement and positioning.
35 Joint Applications TLO: (JB)	Given a tactical scenario, describe U.S. Army's doctrine concerning military operations other than war.
36 Joint Applications TLO: (JC)	Given a tactical situation, plan for the employment of Marine and Naval surface fire support (NSFS) assets.
37 Joint Applications TLO: (JD)	Given a scenario involving joint and light forces, employ light or heavy forces in conflict. (LIC Offensive Scenario PE)

APPENDIX C

DEFINITIONS OF COGNITIVE LEVELS USED FOR TERMINAL LEARNING OBJECTIVE CLASSIFICATION

Extracted from the U.S. Army Command and General Staff College (CGSC) (1988, November).
Author's handbook. Fort Leavenworth, Kansas.

DEFINITIONS OF COGNITIVE LEVELS USED FOR TERMINAL LEARNING OBJECTIVE CLASSIFICATION

Levels of Learning Objectives

According to Bloom and others, there are six levels of learning objectives in the cognitive domain: KNOWLEDGE, COMPREHENSION, APPLICATION, ANALYSIS, SYNTHESIS, and EVALUATION. (Knowledge is the lowest level and each level in the cognitive domain is of a higher order than the one preceding it.) If an author requires a higher level of learning, the level should "tie in" to a comparable level of the cognitive domain of learning objectives. The following definitions of the levels in the cognitive domain may be used to "tie in" to the level of learning an author wishes students to attain.

- KNOWLEDGE means—
 - *Recognition* of specifics and bits of information, i.e., specific symbols (verbal and nonverbal) or specific facts (dates, events, persons, and places).
 - *Familiarity* of ways and means of addressing specifics, e.g., consciousness of correct form, organization, chronological sequences, and methods (knowledge of—not application of).
 - *Recall* of principles and generalizations, e.g., major schemes and patterns by which phenomena and ideas are organized; recall of major generalizations, and/or theories about particulars, places, events, and attitudes.
- COMPREHENSION means—
 - *Translation* of form or appearance of communication to another without changing the meaning or intent, e.g., change mathematical verbal material into symbolic statements and vice versa.
 - *Interpretation* of form or appearance of communication that involves a reordering, rearrangement, or new view of another's material, e.g., ability to grasp the thought of the work as a whole at any desired level.
 - *Extrapolation* by creating the extension of trends or tendencies beyond given data to determine the implications, consequences, corollaries, or effects that are congruent with the conditions described in the original source.
- APPLICATION means that, when given a new situation, the learner will use the most appropriate abstractions without being prompted or shown how the abstraction is used in the situation. It is the ability to predict the probable effect of a problem, based on previous theory.
- ANALYSIS means breaking a universal set into its constituent elements, i.e., breaking down a list of facts from a given hypothesis; being able to state general techniques used in persuasive material, such as advertising and propaganda; or checking the consistency of hypothesis with given information and assumptions.
- SYNTHESIS means to create or put together, using imaginative skills, a whole, i.e., skill in developing a plan that requires organization of ideas, conditions, and constraints; development of a communication that conveys ideas, feelings, and/or experiences to others; or the ability to make mathematical discoveries and generalizations.
- EVALUATION means to make both quantitative and qualitative judgments about what material and methods satisfy criteria, such as the ability to assess logical fallacies in arguments; the comparison of major theories, generalizations, and facts of a given topic; and the ability to judge external standards.

Action Verbs

Note the list of action verbs shown on the next two pages. These words are not only “actor” verbs but are also used to indicate the levels in Bloom’s taxonomy. They *indicate* but do not necessarily *determine* the level. For example, using the action verb “relate” in a task statement does not guarantee the level of comprehension, since the verb “relate” also occurs in the list at the levels above comprehension. The level is best identified by

- The action verb indicator.
- The wording in the TASK, CONDITION, and STANDARD must conform to the definition of the level desired

Example:

TASK: Develop an OPLAN or OPORD.

CONDITION: Given the data about unit size, weather, terrain, tactical situation, and current and potential resources.

STANDARD: The OPLAN or OPORD will be judged by a jury of experts on the basis of the standard five-paragraph OPLAN or OPORD specified in FM 101-5.

At first glance, the verb “develop” fits in the application level. At second glance, the data in the condition might place the objective level at analysis or synthesis. By studying the standard, it becomes obvious that it is at the synthesis level, since data must be used to create or assemble the OPLAN or OPORD.

Action Verbs

Classified verbs according to Benjamin S. Bloom's *Taxonomy of Educational Objectives: Handbook I: Cognitive Domain*:

KNOWLEDGE	COMPREHENSION	APPLICATION	ANALYSIS	SYNTHESIS	EVALUATION
acquire	arrange	apply	analyze	alter	appraise
attend	categorize	calculate	appraise	calculate	argue
choose	change	change	break down	categorize	assess
collect	chart	choose	categorize	change	compare
complete	cite	classify	classify	classify	conclude
copy	circle	compute	combine	combine	consider
define	classify	conduct	compare	compile	contrast
describe	compile	construct	conclude	compose	critique
detect	conclude	demonstrate	contrast	conduct	decide
differentiate	conduct	develop	criticize	constitute	describe
distinguish	convert	discover	deduce	construct	discriminate
duplicate	defend	employ	defend	create	explain
find	demonstrate	generalize	detect	deduce	interpret
identify	determine	manipulate	diagram	derive	judge
imitate	diagram	modify	differentiate	design	justify
indicate	differentiate	operate	discriminate	devise	recommend
isolate	distinguish	organize	distinguish	develop	relate
label	document	predict	evaluate	discover	standardize
list	draw	prepare	formulate	discuss	summarize
mark	edit	produce	generate	document	validate
match	estimate	relate	identify	expand	
name	explain	restructure	illustrate	explain	
order	extend	show	induce	formulate	
outline	extrapolate	solve	infer	generalize	
place	fill in	transfer	outline	generate	
recall	follow	use	paraphrase	modify	

KNOWLEDGE	COMPREHENSION	APPLICATION	ANALYSIS	SYNTHESIS	EVALUATION
recognize	formulate		plan	organize	
reproduce	gather		point out	originate	
select	generalize		present	paraphrase	
state	give example		question	plan	
underline	give in own words		recognize	predict	
	illustrate		relate	produce	
	infer		save	propose	
	interpolate		select	rearrange	
	interpret		separate	reconstruct	
	itemize		shorten	relate	
	locate		structure	reorganize	
	make		subdivide	revise	
	organize			rewrite	
	paraphrase			signify	
	predict			simplify	
	prepare			specify	
	quote			summarize	
	read			synthesize	
	rearrange			systemize	
	record			tell	
	relate			transmit	
	reorder			write	
	rephrase				
	represent				
	restate				
	summarize				
	translate				
	update				

APPENDIX D

REVIEW OF AUTHORING AND PRODUCTIVITY SOFTWARE

REVIEW OF AUTHORING AND PRODUCTIVITY SOFTWARE

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Review of Authoring and Productivity Software

The software reviewed in this document is available in ARL's multimedia lab at Fort Sill, Oklahoma, the BRIDGE. This document provides the potential user with each software's function, potential classroom uses, design structure, and its pros and cons, as identified by the manufacturers' information, and a variety of on-line reviews.

Multimedia Authoring Tools

Multimedia authoring tools are used in the development of business, education, and entertainment *titles*. Multimedia can be used to deliver more effective presentations, allowing for not only text and pictures but also video and animation. Even the presenter can be eliminated when viewer-interactive presentations are used. Examples of this are computer-based training (CBT) and store kiosks or self-running multimedia presentations.

<u>TOOL</u>	<u>PROVIDER(S)</u>
Authorware 4™	Macromedia
Director™ 6.0	Macromedia
ToolBook II Instructor™ 5.0.1	Asymetrix
Quest™ Net +	Allen Communications

Each of these tools has its own strengths and weaknesses.

Although Authorware™ has always had the largest installed base of users of CBT development tools, ToolBook is the Army's standard for CBT.

Authorware 4™ by Macromedia

What is it?

Authorware™ is a full-featured multimedia authoring package for the non-programmer and those dis-inclined to learn programming. With Authorware™, you create your titles using icons on a flow line, which is similar to a hierarchical flowchart. Creating titles in Authorware™ is a process of dragging icons onto the flow line and then defining their content, which controls how objects behave on the stage.

Authorware™ is a powerful, sophisticated program. You can create several types of interactivity without having to write computer language scripts—buttons and several common responses are already built in. There are three primary components of Authorware™:

- Icons - Each icon type performs a different function. These are used for creating interactivity and alternate paths that the title can take, depending on user actions such as clicking on buttons or other hot links.
- Flow line - A series of icons arranged along a hierarchical chart, similar to a flow chart. The flow line controls the flow of the titles, and maps, or sub-flow lines, which allow you to change the direction of the titles accessed by user input.
- Stage - The area where the title displays and represents the computer screen from the perspective of users (the user interface). Upon it, you can create simple animations and some “slick” transitions.

Classroom Use:

As with all the authoring tools, Authorware™ can be used to create

- multimedia presentations, and
- computer-based training (either group or individual).

Functionality:

- **Operating Style.** With Authorware™, you create your titles using icons on a flow line, which is similar to a hierarchical flowchart.
- **Programming Language.** Authorware's™ scripting language is not an elaborate code like Director's™ Lingo; it is more of a macro language with one-line commands.
- **Web.** Shockwave for Authorware™ is a web browser plug-in that plays Authorware™ titles on the web page. Shockwave itself now supports streaming (which allows a Authorware™ title to begin playing while it is still downloading). It is a far more viable option for web developers who want to add CD-ROM-like features and animations. According to Macromedia, Shockwave will begin playing multi-megabyte files within seconds of beginning the download.

With version 4.0 and the separation of content and structure, it is possible to use the hybrid approach to keeping media on the CD-ROM and using the web for timely updates.

Macromedia has implemented such essential capabilities as linking and managing external content, compressing files, supporting fundamental web formats such as graphics interchange format (GIF) and portable network graphics (PNG).

- **User Interactivity.** While Authorware™ provides many more built-in routines for creating interactivity, to create sophisticated titles that access databases and return responses and calculations of user responses, you will have to use Authorware's™ scripting language.
- **Interoperability.** Authorware™ supports most of the leading file formats, including Windows™ Waveform sound file, musical instrument digital interface (MIDI) sound file, Microsoft Video, QuickTime, and others.

Authorware™ files have binary file compatibility, which is a real time saver. When you save a file on a Windows™ machine, you can run it directly on a Macintosh. There are still discrepancies between fonts on PCs and Macintoshes that can corrupt your layouts. You may have to buy both Macintosh and PC versions to handle the fundamental differences between the two.

Authorware™ Synergy (a software not currently available on the BRIDGE) lets Designer's Edge™ (a pre-authoring tool available on the BRIDGE) users create applications in Authorware™ 4.0 at the push of a button. Course maps, navigation, and all the storyboard content (backgrounds, buttons, sounds, and all text) are automatically part of the basic Authorware™ application created by Designer's Edge™.

- **Distribution of Titles.** The Authorware™ file acts as a shell, maintaining pointers to clips contained in the title. It also contains instructions about when, where, and how the clips and other files are to behave. This makes for smaller multimedia files but causes a little more work for you when you distribute the titles. You will often have to include sound and movie drivers, as well as all of the supporting clips. The advantage of this approach is that you can create titles that can be distributed on floppy disks, as long as you do not make them exceed the 1.44 MB supported.

In addition, Authorware™ can create Hybrid CD or web applications in which you ship a CD to users with static files, such as video and audio, and use the web for updating information.

Advantages:

- With good debugging tools and excellent graphics handling, Authorware™ remains a strong program for developing computer-based training and kiosk applications.
- Authorware™ excels at the design-intensive aspects of creating multimedia applications, such as defining multiple states for a button's appearance.
- Authorware™ now allows you to have many multi-dimensional lists. This makes all kinds of functionality that used to be tedious or tricky much more straightforward.
- Authorware™ directly supports (Windows™ platform only) ActiveX controls. ActiveX gives Authorware™ access to many common widgets that are not in the product. It is easy to embed objects such as Acrobat™ (not currently available on the BRIDGE) reader or spreadsheet-like grid control.
- Authorware™ provides links to the web pages discussing how to use ActiveX, addressing ease-of-learning issues.
- With version 4, content (such as graphics, movies, and sounds) can now exist outside the application instead of combined into one large file. This re-engineering of the underlying architecture can better take advantage of the internet as a means of delivery.
- Version 4 is much easier to use. When you move the cursor over an icon, you get a standard "tool tip" describing it. Not only is there a much improved Windows™ help system, there is also a wide range of highly effective "show me" applications available from the help menu.

Disadvantages:

- Macromedia prefers to give you free rein for interface design, but the trade-off is the inability to automate some tasks.
- Although Authorware™ (and the Studio) supplies a solid set of tools for creating design-intensive CBT and kiosk applications, getting the most from the bundle requires capable scripting skills.
- Just as with Director™, Authorware™ makes you script when a dialog interface would have worked just as well.
- Authorware™ needs structured query language (SQL) coding for working via open database connectivity (ODBC); too much scripting is required.
- To use the newly supported GIF and joint photographic experts group (JPEG) formats, you will need to include a separate Xtra when you ship the application.

- With content (such as graphics, movies and sounds) now outside the application, those who run files may experience a performance "hit." However, you can resume storing media internally if that happens.

- ActiveX capabilities require the user to have the correct versions of three files beyond the Active X control, and it is difficult to tell exactly what the user has. The user must have a 32-bit platform and have it set up for ActiveMovie. In addition, the user must have Internet Explorer™.

Director™ 6.0 by Macromedia

What is it?

Director™ is a complete solution for high-end multimedia authoring. It allows you to create highly interactive multimedia presentations, along with animation, movies, and games. In addition, Director™ contains a built-in paint applet for creating bitmap graphics directly in your titles, and it contains built-in frame-based animation tools.

Director™ is based on the metaphor that you are a director creating a movie. You work with a cast that contains all of the elements you plan to include in your performance and then arrange them upon a stage. When creating titles in Director™, you work with four major components:

- Internal Cast - Holds all elements of your presentation, including graphics, animation, video, sound, text, scripts, and color palettes.
- Score - The grid for delineating cast elements over time.
- Stage - The area on screen where the presentation takes place.
- Script - A small program written in Director's™ Lingo language that allows you to include interactivity in your titles.

The Director™ 6 Multimedia Studio (available on the BRIDGE), provides a supporting cast for Director™. SoundEdit™ 16 2.2 is a powerful, easy-to-use audio editor; xRes 3 is a solid image-editing package; and Extreme 3D™ 2.0 (reviewed in the Graphics Tools section) is an industrial strength 3-D modeling and rendering package. All the programs have similar interfaces and work well together.

Classroom Use:

As with all the authoring tools, Director™ can be used to create

- multimedia presentations, and
- computer-based training (either group or individual).

Functionality:

- **Operating Style.** Director™ takes a frame-by-frame, time-line-oriented approach; when you run a project, playback proceeds sequentially unless a script tells it to jump to a specific frame.

- **Programming Language.** Lingo, Director's™ object-oriented scripting language is not an easy language, but it can be learned with some effort on an as-needed basis.

- **Web.** Macromedia has developed Shockwave for Director™, a web browser plug-in that actually plays Director™ movies on the web page. Shockwave can be used with Netscape Navigator™ browser and Microsoft Explorer. Shockwave itself now supports streaming (which allows a Director™ movie to begin playing while it is still downloading). It is a far more viable option for web developers who want to add CD-ROM-like features and animations. Director™ 6 also supports browser scripting; using JavaScript or Microsoft's VBScript, you can control Shockwave movies, for example, pause and resume playback or jump to a specific point.

- **User Interactivity.** With an extensive knowledge of Director's™ programming language, Lingo, one can make Director™ movies do nearly anything. For more complex operations such as tallying user responses to questions, hooking into databases, and returning answers to queries, you will need to use Xtras (written in C code). There are a number of off-the-shelf Xtras already created that ship with Director™ or can be purchased to perform many commonly needed tasks and simply need to be accessed by the Lingo script.

- **Interoperability.** Director™ allows you to create self-contained movies that will run on any system, even if that computer does not have Director™ installed. Director™ files are cross platform; you can work on them in either Windows™ or on a Macintosh. However, there are inherent differences in the two architectures in how they handle text, graphics, sound, and video. You may need to make some modifications in your files to assure cross-platform "playability."

- **Distribution of Titles.** Most Director™ files are too large for a single floppy disk, which is why most multimedia authors distribute Director™ movies on CD-ROM. (The BRIDGE has the ability to make a limited number of demonstration CDs.)

Advantages:

- Director™ is the premier tool for professional multimedia development. It offers more options for tuning performance, superior animation features, and stronger ties to the web. No other authoring program provides a more powerful mix of features, productivity aids, and performance.

- Director™ allows the developer to keep all supporting files in the same file as the title itself.

- The design structure of Director™, which uses a frame-by-frame time-line-oriented approach, is ideal for creating animations.

- No other authoring tool can touch Director's™ animation features. Director™ 6 allows as many as 120 drag and drop elements (called sprites) on the Stage simultaneously, and you can animate each one as quickly as 500 frames per second.

- Director™ 6 is unmatched in its built-in help system. It now features web links that take you directly to relevant areas of Macromedia's web site, where you can download examples, read new tips, and get late-breaking information.

- One of the biggest benefits of using Director™ to create multimedia titles is that the files are compatible with the Macintosh version, so it can run on a Macintosh as long as all of your supported (linked) files (such as video clips) are cross-platform compatible. Using Adobe Premiere™ (not currently available on the BRIDGE) allows you to make movies in both of the popular desktop computer formats, Microsoft Video (AVI) and Apple Quick Time (MOV).

- Director™ 6 supports multiple Score windows, giving you numerous views into a project's time line. You can set different zoom scales and display options for each window and sprites from one window to another.

Disadvantages:

- The design structure of Director™, which uses a frame-by-frame time-line-oriented approach, means extra work when you are creating interactive projects such as CD-ROMs. To keep a particular scene visible until, for example, a user clicks on a button, you must write a script that tells Director™ to play that frame over and over again. You have to fight the program's innate desire to play your project from start to finish with no pauses.

- The time line approach and heavy reliance on scripting complicate authoring.

- Director™ is a more difficult to learn than some other authoring tools. Director™ has always had a steeper learning curve than the competition because it takes a frame-by-frame time-line-oriented approach.

- Just as with Authorware™, Director™ makes you script when a dialog interface would have worked just as well.

- In order to create interactive titles, the developer must be able to use Lingo, Director's™ object-oriented scripting language

- Keeping all supporting files in the same file as the title itself, you may have problems with file size at the time of distribution.

- Although Director™ allows you to create multimedia titles in Windows™ that are compatible with the Macintosh version, one must purchase the Windows™ version to create Windows™ titles.

Toolbook II Instructor™ 5.0.1 and 6.0 by Asymetrix

What is it?

ToolBook is on the extreme high end of multimedia programming. While it is a program powerful enough to allow you to create virtually any type of multimedia title, mastering ToolBook is very difficult and requires a strong commitment.

ToolBook multimedia titles are called books, and each window (or screen) in the book is called a page. Creating titles, sometimes called applications, in ToolBook consists primarily of three components:

- Objects - a text block, graphic, button, movie, sound, and so on. Even the book itself is an object. Objects contain content.

- Events - This is what happens while the book is running. An event can be a mouse click, going to a new page, and so on. You can define your own events and assign them to objects.

- Handlers - Program code, every handler initiates an event.

When creating a ToolBook book, you place objects on pages and then write handlers that correspond to events associated with each object, which in turn are governed by the book's script, or programming language that controls the application.

Classroom Use:

As with all the authoring tools, ToolBook can be used to create

- multimedia presentations, and
- computer-based training (either group or individual).

Functionality:

- Operating Style. In ToolBook, an application is a "book" comprised of "pages."
- Programming Language. You use ToolBook's OpenScript language to control objects' behavior, such as movement, length of play, and colors. In object-oriented ToolBook, each item (from the smallest graphic or button to the background, page, or overall book) is a discrete object with its own properties. You can select or modify these properties through context-sensitive object properties dialog boxes, OpenScript, or the right-mouse-button pop-up menu. In ToolBook's programming-based environment, objects also have such values as true, false, red, and so forth.

ToolBook helps you automate programming tasks in a variety of ways through the New Book Specialist, AutoScripts, or widgets. All anticipate the most common multimedia actions and needs. The New Book Specialist queries the user about layout, defaults, and page size, then sets book and page properties and creates a template book.

- Web. Instructor speaks the language of the internet (hypertext markup language [HTML] and Java), delivering platform-independent courseware; no plug-in is required.
- User Interactivity or Management. The user can modify question response parameters and provide feedback and specify remedial options. Assists users with managing courses, handling student enrollments, and tracking student performance. However, getting there requires you to master the use of handlers and the program's OpenScript language. This process requires a lot of trial and error, debugging, and patience.
- Interoperability. Uses HTML (WWW programming language) and Java (cross-platform programming language). ToolBook, a WindowsTM 3.1 application, now also plays back on WindowsTM 95.

ToolBook Synergy lets Designer's EdgeTM (a pre-authoring tool available on the BRIDGE) users create applications in ToolBook at the push of a button. Course maps,

navigation, and all the storyboard content (backgrounds, buttons, sounds, and all text) are automatically part of the basic ToolBook application created by Designer's Edge™.

- **Distribution of Titles.** Toolbook enables development, distribution, and management of interactive courseware over internet, intranet, LANs and CD-ROM.

- **Management.** Toolbook Librarian, version 2.0 (not currently available on the BRIDGE) is a product you purchase separately and install on your web server.

Advantages:

- The product's true strength lies in its programming language, OpenScript. Programming can be complicated, but the results are very impressive.

- If you want to create basic multimedia applications without database access, you really do not need to touch the code.

- A sufficient and well-thought-out interface with floating palettes of graphics features lets you access features easily.

- Widgets, selected from the widget catalog, are more elaborate, prescribed items such as "video widgets," which contain video display areas with predrawn and prescribed playback controls. Enables the use of more than 200 widgets, including question types, action buttons, bookmarks, 3D layout elements, data validation, media clip widgets, navigation, response checking, special fields, tools, and examples. ToolBook also includes widgets for 3-D buttons, bookmarks, elapsed time indicators, and questions and responses.

- ToolBook's object or properties method offers a consistent approach across all elements. The object and properties lists help you keep track of the scripts, properties, and values for a large number of elements.

- Using ActiveX support with ToolBook II Instructor™ 6.0, you will not have to wait for the next version of ToolBook to get the functionality you need. You can select one of the catalogs of ActiveX components and find the component that provides the functionality you need.

- Version 6 has a new hierarchical properties browser for viewing all properties of all objects.

- ToolBook assembles elements professionally and provides strong documentation.

- Employs a variety of question types such as multiple choice, true and false, arrange or connect objects, fill in the blank, matching, text ordering, and highlighting.

- Allows users to modify question responses by scoring options, weighing answers, maximum value, time and try limits, automatic reset, and randomization.

- Provides feedback and specifies remedial options and permits users to save their favorite widgets in a "hot list" for immediate access.

- Layout options include more than 100 templates and the ability to preview, modify, customize, or augment any layout.

Disadvantages:

- The book metaphor does not offer a bird's eye view or an icon-based flowchart of the pages and their links—a serious drawback for users who plan to construct a large application with complex links or large multi-linked titles.
- In ToolBook, you can access information only on an object-by-object basis, since ToolBook does not use the icon flowchart that products such as Authorware™ have.
- Although you can access everything from the basic ToolBook page display window, ToolBook's graphics features include only lines, ellipses, polygons, and line ends—unlike IconAuthor (an Authoring Tool not available on the BRIDGE), which offers more extensive graphics features.
- With ToolBook, you need an additional database connection for database access capabilities.
- In order to create highly interactive titles, the user must master the use of handlers and the programs' OpenScript language.
- ToolBook's programming language, OpenScript, is stubbornly omnipresent (unlike Director's™ language, Lingo, which stays behind the scenes) and is difficult to use, especially for beginners.
- The problem with using ActiveX capabilities is that the user must have the correct versions of three files beyond the Active X control, and it is difficult to tell exactly what the user has. The user must have a 32-bit platform and have it set for ActiveMovie. In addition, the user must have Internet Explorer™.

Quest™ Net + by Allen Communications

What is it?

Quest™ Net is an authoring tool for Windows™ to create interactive training and education applications, kiosks, and other highly interactive presentations. It is fast and easy click and drag object authoring. This latest version of Quest™ introduces powerful new interactive features that leverage the power of the internet, provide comprehensive computer-managed instruction (CMI) capabilities, and infuse new hypertext functionality. Quest™ was built by instructional experts to enhance the creation of interactive training and education titles by using an approachable, reusable, powerful, and extensive object-oriented architecture.

It was built to think like an instructional designer. It offers two main levels of development: the title design level and the modules, lessons, frames, and paths. The frame level gives developers the development tools (graphics, animations, text)—everything necessary to create powerful multimedia applications in one “what you see is what you get” (WYSIWYG) environment.

Classroom Use:

As with all the authoring tools, Quest™ Net + can be used to create

- multimedia presentations, and
- computer-based training (either group or individual).

Functionality:

- Operating Style. Object-oriented, event-driven architecture.
- Programming Language. For those who demand extra power, American National Standards Institute (ANSI) C is embedded in Quest™, which means users can access the power of C or directly link to other C-based programs, from within Quest™.

The “Quest™ C Coach” lets novices select options from dialogue boxes to create C code. Through a simple dialogue box, users can access programming functions, variables, and command statements to control and manipulate live objects.

C programmers, on the other hand, have the power to control multimedia objects. Developers have virtually unlimited multimedia power in a true multitasking authoring system; animations, audio, video, user interactions, and C code can all run simultaneously. C programs can be written and compiled without going to an exterior editor.

- Web or User Interactivity. Quest™ harnesses the data transfer power and file access capabilities of the internet, using the internet for both peer-to-peer communication and client-server communication. This new capability allows Quest™ titles to communicate with each other and access files across an internet connection. Users of Quest™ will be able to “internet-enable” their titles using several new features that are available on the internet tool tab within the frame editor.

Universal resource locator (URL) capabilities allow a Quest™ title to read files stored on any web site, providing a means to update or add content to a Quest™ title during run time. The power, ease of use, and functionality afforded in Quest™ go far beyond the restricted offerings of HTML. Quest™ gives you unlimited interactive options that can be built quickly using click-and-drag objects in a WYSIWYG environment. In other words, you are not limited to a small subset of operating system functions typically associated with internet applications; Quest™ gives you all the features you need to create dynamic, powerful education and training applications using a series of objects, pull-down menus, frames, and boxes.

Quest™ Net+ delivers hypertext capabilities. When creating or importing text, authors can automatically turn text into “hot” words. This hypertext feature is integrated directly into Quest’s™ object-oriented, event-driven architecture. This allows simple hyperlink selection to use all of Quest’s™ capabilities as feedback, opening up many unique and exciting opportunities for new levels of interactivity.

- Interoperability. Quest™ lets Designer’s Edge™ (a pre-authoring tool available on the BRIDGE) users create applications in Quest™ at the push of a button. Course maps, navigation, and all the storyboard content (backgrounds, buttons, sounds, and all text) are automatically part of the basic Quest™ application created by Designer’s Edge™.

- Distribution of Titles. Quest™ titles can be distributed via the internet or CD.

- Management. Quest™ includes an integrated CMI utility called the Quest™ Manager. Quest™ Manager with its easy-to-use interface and compatible Quest™ objects is a great solution for data tracking and student management needs. There are two main pieces to the new CMI features in Quest™: the new Quest™ Manager, and a set of new CMI objects available from within Quest's™ Frame Editor.

Quest™ Manager is a shell used by administrators to manage users and courses and by students to control the presentation of assigned course activities. To support Quest™ Manager, three new CMI objects have been added to the Frame Editor. These new objects employ a user-friendly wizard and can interface directly with Quest™ variables for reading and writing data. When accessing variables, the new objects can automatically convert data between standard data types such as integers, floats, character strings, and so forth.

Advantages:

- Since Quest™ allows separation of content from structure and does not store duplicate media elements, it is easy to control the size of your course for easy delivery over the internet.
- Quest™ offers unique functionality, which allows the author to selectively define which elements of a course (e.g., those required of a particular student) need to be downloaded to the internet. This helps optimize productivity and eliminates the long waiting periods that are often associated with pulling information off the internet.
- Quest™ offers an extensive management tool.
- Unlike many other authoring tools, the hypertext links setup in Quest™ can trigger any Quest™ object, including video, audio, graphics, branching, pop-up windows, and so forth—not just text-based events.

Disadvantages:

- The problem with using ActiveX capabilities is that the user must have the correct versions of three files beyond the Active X control, and it is difficult to tell exactly what the user has. The user must have a 32-bit platform and have it set for ActiveMovie. In addition, the user must have Internet Explorer™.

Graphics Tools

Five graphics tool programs are available on the BRIDGE:

<u>TOOL</u>	<u>PROVIDER(S)</u>
Photoshop® 4.0	Adobe
PageMaker® 6.5	Adobe
Illustrator® 7	Adobe
Extreme 3D™ 2	Macromedia
3d Choreographer Deluxe 2.7	Animated Communications

The Adobe family of graphics tools, Photoshop®, PageMaker®, and Illustrator®, provide you with the tools for demonstrating creativity with photographs, text, and animation. The results of your work can be used as graphic representations in presentations using PowerPoint or authoring tools, and in the development of CBT and web pages.

The 3D animation tools provide yet another level of interest in class presentations, CBT, and web pages by providing live animations that may capture the interest of the user.

Photoshop® 4.0 by Adobe

What is it?

With powerful tools for editing, manipulating, and collaging bit mapped images in creative ways, Photoshop® is the most popular professional photo editing program. Bitmap images, also known as paint-type images, are pixel or dot based. Each pixel contains one bit of color information. Bitmap images can be difficult to edit or resize without using an image editing tool such as Photoshop®, and depending on size, resolution, and color depth, bitmap files can be enormous, requiring more storage space than drawn images (as those created in Adobe Illustrator®, which is available on the BRIDGE).

Whether for photography, illustration, fine art, animation, or on-line development, Adobe Photoshop® has long been the program of choice, thanks to its power and its masterful interface.

With this latest release, Adobe has refined the program even more, adding such niceties as batch processing and nondestructive adjustment layers. At first glance, Photoshop® 4.0 does not appear to be overflowing with new features or radical changes, but as you use it, you will find many well-designed, tightly integrated improvements.

Photoshop® 4.0's complement of tools includes the new Actions and Navigator palettes, a revamped main toolbox, and an enhanced layers palette.

Interface changes, on the other hand, are apparent from the moment you launch the program; palettes, dialog boxes, and buttons have been recrafted, with a slight three-dimensional appearance; menus have been reworked; and the primary toolbox has been reorganized.

Classroom Use:

Photoshop® can be used to edit or enhance photographs used in

- presentations via presentation software or authoring tools,
- presentation handouts,
- computer-based training CBT via authoring tools,
- newsletters,
- printed material (such as posters)
- flyers,
- web pages, and so forth.

These images can be imported into any of the authoring tools, presentation tools, or directly onto web pages designed within the classroom, via Netscape Navigator™ Gold (available on the BRIDGE).

Functionality:

- Operating Style. Photoshop® remains a direct pixel editor only, providing full visual feedback about edits.
- Programming Language. The Actions palette, which lets you easily create macros, has inspired a number of on-line laments for the now-dead commands palette. True, defining an action to replace a favorite command is a time-consuming, multi-step task, and although it supports DOS script as an Apple event, Actions is not a full-blown scripting language, and it has some limitations. You cannot record the contents of calculations or apply image, for example. However, it can do everything commands could do and much more. It lets you automate many Photoshop® tasks without learning scripting syntax, making it accessible to a wider range of users, and it provides a solid foundation for full-blown scripting capabilities in a future version.
- Web. Photoshop® 4.0 has several features to ease the development of graphics for the web.

Photoshop® now ships with the GIF89 an export filter, which lets you save indexed color images as GIF or interlaced GIF files. In addition, the filter enables you to view an image's color palette and specify which colors are transparent. The indexed color mode change dialog box allows you to select web as a palette option for remapping an image to the 216 colors common to Mac OS and Windows™ web browsers.

Version 4.0 also supports Macintosh drag and drop from Photoshop® to PageMill 2 (not available on the BRIDGE), Adobe's WYSIWYG web page creation tool.

- Interoperability. Photoshop's® interface looks almost identical to that of Illustrator® 7.0 and PageMaker® 6.5. Even better, the three programs integrate completely, making for a smooth, comprehensive, cross-platform graphics suite. It is clear that Adobe plans to make a seamless interface among its products.

Photoshop® files can be imported into any of the authoring tools, presentation tools, and onto the web via Netscape Navigator™ Gold.

Advantages:

- Tools are grouped more logically, with pop-out palettes to access the different flavors of some multi-function tools, as is done in Illustrator®.
- More items are available from the toolbar, so you can navigate more easily by clicking or option clicking.
- The Action palette lets you batch process images. Easy to use and very functional, the Action palette is a wonderful time saver.

- The Action palette enables you to create scripts of multiple actions that can be played on any image at any time. A set of simple VCR-like controls at the bottom of the palette allows you to record and play action sequences.

- To provide variable control, you can set a break point next to any item within an action. This tells Photoshop® to pause and wait for user input, affording you the opportunity, for example, to adjust the settings for a particular operation.

- The Actions palette contains the simple yet powerful batch command, which you can use for applying an action script to a batch of images.

- Photoshop® now handles image manipulations such as brightness, contrast, color balance, levels, and curves much like any other layer, through a feature called the “adjustment layer.”

- Adjustment layers add precise controls to composite images. You can apply opacity levels and blend modes to these layers, control which underlying layers they affect, and paint gray scale levels to modulate the effect.

- Adjustment layers let you perform nondestructive, modifiable edits. Using them, you can perform tonal adjustments and some special effects on entire layers or selectively, using brush tools, without altering your original image data. This way, you can quickly and easily try many different edits without sacrificing your original image.

- Nine types of adjustment layers are available, including curves, levels, hue adjustment, and posterize. After you have selected a layer type, the standard dialog box for the chosen effect appears.

- Effects applied via an adjustment layer affect only layers below that layer, unless you confine them to a single layer. Like any other type of layer, an adjustment layer can be hidden or deleted at any time, restoring all affected layers to their original state.

- Adjustment layers can be dragged from one image to another to quickly apply identical edits to multiple images.

- By default, an adjustment layer effect is applied uniformly over the whole image. However, by painting in an adjustment layer with brush tools, you can apply the chosen effect in varying amounts to any part of your image. So, for example, by painting a color-correction adjustment layer, you can apply varying amounts of correction to different portions of your image. This approach is a vast improvement over that of Photoshop® 3, which required you to create a separate mask for each color adjustment.

- For the operations they support, until you flatten the file, adjustment layers provide a form of nonlinear, unlimited undo. Because you can always remove an adjustment layer, you do not have to worry about saving multiple versions of a document.

- Adjustment layers do not add to the file size until you start painting them.

- Adobe promised faster, smarter processing for large and high-resolution images, and Photoshop® 4.0 delivers.

- As in a drawing or computer-aided design (CAD) program, you can display nonprintable grids and guides in your Photoshop® image. With “snapping” turned on, layers and selections automatically snap to the nearest grid line, greatly simplifying the alignment of multiple layers.

- The view menu, a smart zoom preview, lets users do delicate work at the pixel level while still moving across the entire image. Users of Adobe’s Illustrator® and PageMaker® will find it familiar.

- The program no longer limits zooms to factors of 2; you can randomly zoom by typing any zoom percentage (to two decimal places) into the zoom box in the lower left corner of a document window. To further aid zooming, the view menu includes new automatic zoom-level commands such as fit on screen, actual pixels, and print size.

- Zooming can also be controlled from the new Navigator palette. The Navigator palette lets you quickly zoom and pan through large images. Displaying a small thumbnail of your document, this palette includes a slider for variable zoom control as well as a draggable selection marquee for interactively panning about in your document. At first glance, the Navigator palette may seem little better than scroll bars, but having zooming and panning so elegantly integrated into a single, simple control is a luxury—especially for high-resolution images displayed at high magnification.

- Photoshop® 4.0's new digital watermarking system from Digimarc lets artists stamp their digital artwork with a virtually invisible copyright notice that can survive even if the image is printed and scanned into a computer.

- Adobe has boosted the speed of screen display and redrawing in Photoshop®, partly because of a variation of on-demand pixel editing. When you edit an image, Photoshop® applies the edit to a significant delay in zooming when Photoshop® applied the edit to another level of display. This improved display handling also lets you open a large file even if you are running out of memory.

- Photoshop® has added a purge command so you can selectively free memory that is being held by undo, the clipboard, a pattern, or a snapshot. As a result, you will no longer experience frequent freezes and out-of-memory messages that previously plagued large image file edits.

- Photoshop® 4.0 generally uses layers more intelligently than previous versions. For example, when you drag and drop or paste selections into a document, the program automatically creates a new layer rather than a floating selection, which unobtrusively keeps your document organized. Although this method can lead to layer “pile-ups,” improved merge tools make consolidation easy.

- The free transform command places handles around the boundary of a layer so you can scale, rotate, or shear it, either by dragging the handles or by entering numerical values in a dialog box, and individual layers can be flipped and transformed. These features are organized in the changed layers palette, which makes it much easier for you to tell which functions affect layers and which affect the whole document. For rotating entire files, the new rotate canvas command simultaneously rotates all layers.

- With the powerful layer mask feature, you can now specify whether a mask should initially hide or reveal its associated layer. You can also create a layer mask from the current selection.

- Photoshop's® gradient tool has been completely redesigned and functions much more like the full-featured gradient controls that are available in expensive, more sophisticated drawing packages. Whereas Photoshop® 3 simply created a linear or radial gradient between the foreground and background colors, Photoshop® 4.0 allows you to create and store multicolored gradients with varying levels of opacity. For example, you can have a gradient that fades from completely opaque blue to 50% opaque red.

- Photoshop® continues to have the strongest set of pre-press tools and the clearest and most precise desktop printouts.

- Photoshop® 4.0 does a good job of color indexing to specific or user-defined color mapping tables, and it outputs to GIF89a, PNG, progressive JPEG, and portable document format (PDF).

- The move tool is the only tool you can use to move the contents of a selection in Photoshop® 4.0. This differs from earlier versions of Photoshop®, in which you used selection tools (the marquee, lasso, magic wand, and pen) both to define portions of an image and to move them. The move tool makes it possible to control selection paths independently of their content. Selection outlines can be moved between layers of a document or even dragged and dropped from one file onto another, which is great for making selections of identical shapes in different images.

- To further aid composition, Photoshop® no longer crops pixels that fall outside the canvas.

- Floating selections have been almost entirely replaced by new layers, which take less memory and exploit the new image cache feature for speedier performance.

- The image cache makes working with layers much quicker. It is basically an internal pyramid sampling scheme akin to the Image VUE (IVUE) file format in Live Picture Inc.'s Live Picture and the Large File Mode (.LRG) file format in Macromedia Inc.'s xRes, but it is transparent to the user, seems to involve less disk access, and does not entail post-processing.

- The image cache accelerates the composition and blending of layers by operating on the visible pixels first, so it gives you faster feedback but does not defer processing of the high-resolution data. At the default setting of Level 4, it increases the file's random access memory (RAM) footprint by about one-third, but if you work with layers, it is a worthwhile trade-off. It also complicates the rules for determining how much RAM you need. Setting the image cache to Level 1 disables the feature, but the only reason to do this is if you are working on flat files in low-RAM situations. There are eight levels in all.

- Image cache makes the program considerably more usable on low-RAM systems.

- Photoshop® can now handle encapsulated postscript (EPS) files from any source.

- Photoshop® 4 will correctly pick up the ColorSync System Profile information and load it into the monitor setup dialog box, although it appears with the uninformative name default. A button in the separation tables dialog box lets you build tables with a specified rendering intent from a ColorSync profile. (The button was also in Photoshop® 3.0.x but only worked with ColorSync 1.0.)

Disadvantages:

- Unfortunately, Adobe has remapped its keyboard shortcuts, Photoshop's® greatest time saver. Adobe claims the changes will enable common shortcuts among future versions of Adobe products, but most experienced users will wince at the thought of having to retrain their hands.

- Since Photoshop® remains a direct pixel editor (not object) only, you will find that file size expands significantly as you add layers, which consumes resources and can decelerate processing and redrawing. The lack of objects means that Photoshop® cannot implement URL embedding.

- If you have limited RAM, you may still have difficulty editing the file. (Ideally, the amount of RAM available for any direct pixel-editing program should be three to five times the file size of the image you are editing.)

- When a layer is copied and pasted onto another image, the adjustment layers associated with it move with it. You have to merge the layers while pasting, which means that you can no longer edit the adjustment layers in the new image.

- Adjustment layers need to be able to perform Gaussian blur and unsharp mask functions.

- Not every feature is scriptable (in the Action palette). Most notably absent is the ability to script the change of a layer's transfer mode.

- Batch processing of scripts within the Action palette that create or delete layers is impractical because, like version 3, version 4.0 requires you to enter a file name when you save any document to which layers have been added or from which layers have been removed.

- Photoshop® 4.0 cannot read Photoshop® 3's commands settings, so you will have to rebuild them if you want to use them in the new version.

- Despite some very useful features, Photoshop® could be a little more web aware. Photoshop® needs the ability to attach URLs to individual layers (as with Fractal Painter 4), to facilitate automatic image map generation. Photoshop's® lack of support for image maps hinders its web functionality.

- The program still needs large amounts of RAM and hard disk space. This version demands a megabyte more of hard disk space than version 3 (or about 10 MB) and at least 10 MB of RAM.

- This version of Photoshop® provides just one scriptable command, do script, which lets an external application trigger a Photoshop® action.

- Both of Photoshop's® rotate features are noticeably slower than rotating in Photoshop® 3. (Rotating using Photoshop® 4.0's numeric transform, in particular, is glacially slow.) This is a concern if you do a lot of collaging and layout work in Photoshop®.

- The total number of pop-out palettes remains the same, but you are likely to use more of them at once in Version 4, making palette clutter a bigger problem. Some of the palettes should be narrower, particularly the layers, channels, and actions palettes, and the restyled information palette is unnecessarily large; the old one grew as needed to display current information, but the new one has a fixed size. A dual monitor setup or a 1,600- by 1,200-pixel resolution monitor is practically a necessity.

- Color-management systems support is weak.

- Photoshop® still needs a real undo tool, but this is a step in the right direction.

PageMaker® 6.5 by Adobe

What is it?

Adobe PageMaker® 6.5 is a program that meets the needs of most traditional desktop publishers and anticipates the needs of most electronic publishers.

Adobe PageMaker® 6.5 has taken great strides in electronic publishing, full-color printing, and automated layout. In this version, Adobe PageMaker® has dramatically enhanced layout tools, which include frames, layers, and automated adjustments. All this new functionality presents stiff competition to QuarkXPress (not currently available on the BRIDGE).

PageMaker's® frames now can contain text or graphics. They provide functions such as vertical

alignment or the ability to “dummy” a layout with place holders. You can convert any PageMaker®-drawn object to a frame, and the links between frames give you much more control over noncontiguous text flow.

PageMaker's® tools palette now contains two columns of tools for creating geometric objects: The column on the left contains the rectangle, ellipse, and polygon icons familiar to PageMaker® 6 users; these are still used to create graphic elements. The tools in the right column look (and behave) just like those in the left, except each bears an X in the center of its icon. You use these tools to create frames that can contain either text or graphics. You use the frame options dialog box to control the appearance of frame contents (alignment and inset of text and graphics and scaling and clipping of graphics).

The main purpose of PageMaker® frames (aside from making the program more accessible to QuarkXPress users) is for creating structured documents with repetitive text and graphics. You can easily template pages by placing empty frames on them and then simply pouring text into them later.

Frames can also be used to create circular or polygonal text without resorting to inside-out text wraps and other time-honored PageMaker® tricks.

Classroom Use:

Students may use PageMaker® in a number of projects:

- newsletters,
- printed material (such as posters)
- flyers,
- presentation handouts,
- web pages, etc.

These images can be imported into any of the authoring tools, presentation tools or directly onto web pages designed within the classroom, via Netscape Navigator™ Gold (available on the BRIDGE).

Functionality:

- Web. Adobe PageMaker® 6.5 is designed to help automate the conversion from paper to screen. With the new auto adjust layout feature, PageMaker® can intelligently rearrange a paper page (tall) into a screen page (wide), moving text and graphics and even sizing them proportionately.

PageMaker® also imports and exports HTML files, complete with in-line graphics and links. PageMaker® is fully hyperlink savvy, whether the links are imported in an HTML file, entered manually, or dragged from Navigator. The link targets can even be previewed in PageMaker®.

When exporting to HTML, you can preserve as much of the page layout as HTML supports, so that columns of text still appear as columns (when viewed with a browser that supports tables). PageMaker® automatically converts tagged image file format (TIFF), EPS preview, PICT (Macintosh's picture image file), and metafile graphics into JPEG or GIF files, and PageMaker's® plug-in architecture should make it easy to add support for new HTML features as they evolve.

The program's new hyperlink palette shows you both the source and the destination of a link. Instead of tediously typing URLs, you can get them from your browser or by importing HTML. An easy-to-access preview mode lets you test the validity of your hyperlinks efficiently. HTML export is less robust. For example, you cannot output a book file to HTML. PageMaker® does earn a few extra points for attempting to duplicate a multi-column layout using HTML tables.

- **Interoperability.** PageMaker's® interface looks almost identical to that of Photoshop® 4.0 and Illustrator® 7.0. Even better, the three programs integrate completely, making for a smooth, comprehensive, cross-platform graphics suite. PageMaker® 6.5 interface refinements unquestionably stamp this version as part of the Adobe software family. Adobe's stated goal was to make PageMaker® more consistent with stable mates Photoshop® and Illustrator®. Reorganized menus, new tools, tabbed palettes, and remapped keyboard shortcuts aim at creating interface consistency with Adobe's graphics applications. It is clear that Adobe plans to make a seamless interface among its products.

PageMaker® files can be imported into any of the authoring tools, presentation tools, and onto the web via Netscape Navigator™ Gold.

Advantages:

- PageMaker® supports multiple layers as well as multiple master pages. A dynamic relationship between the layers palette and the objects in a publication lets you manage complex layouts very easily.
- Moving an object to a different layer is as simple as dragging the object's icon from the current layer to the target layer in the palette.
- Because you can turn layers on or off at print time, you can create different versions of a document.
- Page layout frames (not to be confused with HTML frames) are included in PageMaker®. Frames let you create layouts you can reuse because the layout is separate from the content.
- The new layout-adjustment feature is especially impressive. This automated function can resize and reposition elements whenever you change the orientation and page size of a publication or apply a new master. Provided that you have adhered to a highly structured layout, the feature lets you easily convert page-based print publications to the horizontal screen layout necessary for web publishing.
- PageMaker® 6.5 includes a valuable selection of additional software: the Adobe Acrobat™ Distiller, Adobe Acrobat™ Reader, Adobe Photoshop® Limited Edition (Windows™ only), and the Adobe type on call CD-ROM with 220 free, unlocked fonts.

- PageMaker® is now more closely linked to Acrobat™, including support for embedding QuickTime movies in a PageMaker® document and publishing it to an Acrobat™ file. Tables of contents and indices are automatically converted to Acrobat™ links and bookmarks.

- PageMaker® 6.5 brings new electronic life to old documents and lets you create original documents simultaneously for paper and screen.

- Photoshop® and Illustrator® users who are new to PageMaker® will appreciate familiar keyboard shortcuts and will also be right at home when using the program's new palettes, which adopt the convenient tabbed design introduced in Illustrator® and Photoshop®. This design allows you to consolidate multiple palettes into one by double clicking on their title bars.

- PageMaker® supports *Commission Internationale de l'Eclairage* (CIE L*a*b) images—essential if you plan to generate Hexachrome separations.

- PageMaker® also has no trouble applying a special effect to an imported bitmap, thanks to Photoshop® plug-ins that can be accessed from within a publication.

- PageMaker's® functions, which include book compilation, table of contents generation, and indexing, are inherently limited but blissfully simple to use.

Disadvantages:

- Although the new palettes in PageMaker® 6.5 are generally liked, it would be best if they used less desktop space. When active (i.e., “rolled down”), they are considerably bigger than their predecessors in PageMaker® 6.0. This may cause headaches for users of smaller monitors or older Macintoshes.

- The often used commands for actual size, fit in window, and so on are buried several items down on the menu. Far more troublesome, the display master items command violates the menu's logic; it is the only command on the menu that affects a page's content, rather than simply the way it appears on screen. Hiding master items actually removes them from the page in question. This command would be better elsewhere or nowhere, since multiple master pages could be used for the same purpose.

- In an awkward twist, with the frame options dialog box, you must set the stroke and fill attributes of the frame itself separately via the element menu. Another annoyance is that once frame options settings are applied, you cannot undo them. Although you can use key strokes to invoke frame options, it would be best if you were able to access them by double clicking on a filled frame as well. Ultimately, a frame palette would be best.

- Frames can also be used to create circular or polygonal text without resorting to inside-out text wraps and other time-honored PageMaker® tricks. However, the kinks are not removed from this yet, however. Trying to align headline text precisely within a circular frame (something that is easy to do in QuarkXPress) took more steps and cumbersome work-arounds than should be necessary.

- Although PageMaker® 6.5 provides the flexibility of creating in layers, this should not be confused with true conditional text as implemented in FrameMaker or Ventura.

- PageMaker's® core composition engine has not been upgraded. You still have to generate typographical effects, such as drop caps or numbered lists, through plug-ins. They are effective but slower and less elegant than true paragraph formats.

- PageMaker® still does not allow you to edit kerning tables, and master pages are still treated as static backgrounds, making it impossible to quickly adjust a master layout for an

individual page. The external table editor utility, which dates from Version 3.0, is a little worn around the edges. For the most part, PageMaker® leaves document-wide functions to its sibling program, FrameMaker.

- Without an upgrade of the core typographic functions, PageMaker® will have a hard time wooing die-hard QuarkXPress fanatics.

Illustrator® 7 by Adobe

What is it?

Adobe Illustrator® is a drawing program that allows you to create vector graphics. Vector graphics, also known as draw-type images, are done mathematically, that is, the computer redraws the shape of an image defined by lines and then renders the image according to formulas. As a rule, vector graphics are small in file size and easy to edit and resize with little impact on image quality. These types of images are used in constructing models in CAD environments, such as architecture or engineering, and in the development of 3-D stills and animation.

Illustrator® 7 is a major redesign of Illustrator® 6. If you are intimately familiar with Illustrator® 6, prepare to enter some alien territory.

Classroom Use:

Illustrator® can be used in any application where vector graphics are required, such as

- presentations via presentation software or authoring tools,
- presentation handouts,
- computer-based training CBT via authoring tools,
- newsletters,
- printed material (such as posters)
- flyers,
- web pages, etc.

These images can be imported into any of the authoring tools, presentation tools, or directly onto web pages designed within the classroom, via Netscape Navigator™ Gold (available on the BRIDGE).

Functionality:

- Operating Style. *.EPS is the native format for Illustrator®. The encapsulated postscript format is a vector file that uses the PostScript language to draw its image.
- Web. Illustrator® offers several new features for web designers, including the ability to select colors using red, green, and blue (RGB), the color system of the web, a 216-color, “browser-safe” palette, and support for URL objects and image maps. It is also easier to switch between gray scale, RGB, and CMYK color spaces. Unfortunately, the color-space-conversion filter does not address gradients, which you have to modify manually.

You can create both client-side and server-side image maps to act as links on your pages. An improved anti-aliasing feature smoothes the edges on exported GIF and JPEG images. Illustrator® now imports more file types, too, reading all major graphics formats, including Acrobat™ PDF and CorelDraw 5 and 6. Plus, Illustrator™ exports to 16 graphics formats, such as TIFF and PNG.

- Interoperability. Illustrator® 7.0's interface looks almost identical to that of Photoshop® 4.0 and PageMaker® 6.5. Even better, the three programs integrate completely, making for a smooth, comprehensive, cross-platform graphics suite.

Illustrator® 7 follows Photoshop's® example of multi-panel palettes, which helps keep on-screen clutter to a minimum. Both programs share commands and keyboard shortcuts for object alignment, color application, grouping, stacking, and layering.

Illustrator® 7.0 is a "core code" release, which means that Macintosh and Windows™ versions are now equal both in features and in interface. This aids those working in a cross-platform environment. It is clear that Adobe plans to make a seamless interface among its products. Illustrator® is fully compatible with Windows™ 95 and Windows™ NT 4.0.

Illustrator® files can be imported into any of the authoring tools, presentation tools, and onto the web via Netscape Navigator™ Gold.

Advantages:

- You can access every tool—bar none—by pressing a letter key. Illustrator's® tool keys are easier to remember and more comprehensive than Macromedia FreeHand 7's function key shortcuts (see Reviews, February 1997). After you memorize Illustrator's® shortcuts, you will be able to switch between drawing, editing, and transforming without shifting your cursor a single pixel.

- Adobe has added all sorts of keyboard tricks and drag-and-drop conveniences; gradients in particular are much easier to edit. If you currently spend a lot of time organizing colors and tints in Illustrator® 6's Paint Styles, with some practice, you will find yourself coloring more quickly and accurately in Illustrator® 7.

- The new product also includes a grid, vertically aligned text capabilities, and a reshape tool that lets you stretch paths along an angled axis. The latter takes a while to get used to, but it makes an interesting addition to the traditional scale tool.

- The new ability to link to placed images instead of forcing documents to embed images reduces file sizes considerably.

- The standouts among the few new drawing features include a tool for reshaping paths and the ability to quickly adjust multiple master fonts.

- Illustrator® 7's most significant addition, image linking, allows you to tag TIFF, JPEG, and other files, rather than parsing the pixels into Illustrator's® native and comparably inefficient PostScript.

Disadvantages:

- Illustrator® still needs work before its web images will match the quality of its printed output. For instance, you cannot use pixels as a measurement unit, making it difficult to determine how large graphics will be when you save them—especially if you export to the Windows™ standard resolution of 96 dots per inch.

- Illustrator® 7.0's GIF and JPEG anti-aliasing, while an improvement over previous versions, is not nearly as effective as the anti-aliasing in CorelXara or the shareware Xara Webster.

- Even though you can access every tool—bar none—by pressing a letter key, some keys make no sense at all, like pressing the N key to cycle between the oval, polygon, star, and spiral tools.

- Illustrator® 7's so-called context-sensitive pop-up menu is the lone interface disappointment. Intended to offer quick access to common commands by control clicking within any tool, it is really context ignorant. It disregards the active tool, always beginning with the shortcuts for undo and clipboard operations (which is out of context) even when they should be dimmed. Finally, the pop-up menu offers no provision for switching to the layer that contains a selected object, the Photoshop® equivalent's best feature. If you want quick access to commands, it is far better to learn the shortcuts.

- Things it cannot do:

- The autotrace tool now recognizes color images, but there is no way to set color tolerance, and the tool still draws just one path at a time.

- You cannot reshape blends, as you can in FreeHand, Corel's CorelDraw, and Deneba's Canvas.

- All three competitors offer more and better special effects functions, while Adobe leaves effects in the hands of plug-in developers.

- Although plentiful and capable, Illustrator's® Pathfinder operations remain tucked away in a remote submenu. We need a palette; we need previews.

- Illustrator® 7 lacks Photoshop® 4's Navigator and Actions palettes.

Illustrator® still zooms and scrolls in giant steps, and scripting is not an option.

Extreme 3D™ 2 by Macromedia

What is it?

Extreme 3D™ 2.0 is an excellent tool for print, animation, web, and multimedia production. It is an industrial strength 3-D modeling and rendering package. Macromedia's PowerPC-only 3-D modeling, rendering, and animation package is as good as its advertising, with an enhanced interface; web graphics support; faster rendering; and powerful new tools, including a particle systems generator and meta-balls. Together, these enhancements make Extreme 3D™ the strongest of all the low to midrange Macintosh 3-D design products.

Extreme 3D™ 2's assortment of powerful 3-D tools is designed for and well suited to web and multimedia designers, and the program comes at a very reasonable price. (It is not a tool for film or video professionals, and it does not aspire to be.)

Classroom Use:

Creating 3-D animations for use in

- presentations via presentation software or authoring tools,
- CBT, and
- web pages.

These files can be imported into any of the authoring tools or directly onto web pages designed within the classroom via Netscape Navigator™ Gold (available on the BRIDGE).

Functionality:

- **Operating Style.** Extreme 3D™ is a Phong-shading, spline-based program.
- **Shading and Rendering.** Extreme 3D™ uses procedural shaders for rendering, and like all other procedural shading mechanisms, they frequently make things look a little too perfect. The included Mondo Map shader provides some relief, allowing you to adjust such properties as bump, specular, and environment, and (for the first time) transparency and luminosity. By adjusting these controls, you can make shaders such as chrome and marble much more realistic. Although Extreme 3D™ lacks a ray tracer (the program provides only Phong shading for rendering), support for shadow transparency in version 2 lets you create soft-edged shadows that look very much like the results of a good ray tracer. Furthermore, the renderer is now fully optimized for the PowerPC, which means shorter rendering times.

Besides these highlights, Extreme 3D™ 2 offers two useful, if less splashy, improvements: Xtras plug-in support allows third parties to develop new lighting and texture modules in the manner of Photoshop™ plug-ins. Version 2 additionally provides full support for hardware QuickDraw 3D acceleration.

- **Web.** Macromedia has made Extreme 3D™ a first rate tool for creating 3-D graphics for the world wide web. The program now renders animations in the GIF89a (animated GIF) and Progressive JPEG formats, and it offers direct support for virtual reality modeling language (VRML) 1 and 2. Extreme 3D™ 2 allows you to attach three types of URLs to an object: Anchor (which links to a web page), Inline (which links to other pieces of 3-D geometry), and Texture Map (which links to texture map images).

In addition to rendering directly to VRML format, Extreme 3D™ provides powerful controls for setting an object's resolution. Particularly useful is the new adaptive smoothing control, which lets you lower a model's polygon count, to minimize the size and download times of VRML scenes.

- **Interoperability.** Extreme 3D™ runs on PCs (it is compatible with Microsoft Windows™ 3.x, Windows™ 95, and Windows™ NT) and Macintoshes. However, the interactive tutorial may not run correctly under Windows™ NT unless you download and apply an upgrade patch from Macromedia's web site.

Version 2.0 incorporates the Macromedia Open Architecture and Information Exchange protocols, which brings a common extensions architecture to the programs in the suite and improves file transfer among them. In addition, the new version supports several internet file formats (GIF89a, Progressive JPEG, PNG, and xRes LRG), along with 3-D metafile (3DMF) and VRML files. You can also attach URLs to objects from within the object's browser.

Extreme 3D™ files can be imported into any of the authoring tools and onto the web via Netscape Navigator™ Gold.

Advantages:

- Extreme 3D™ 2's best new features (the Particle and Metaform tools) are fantastic enhancements.
 - Similar to the meta-balls feature of more expensive 3-D programs, such as Strata StudioPro (not available on the BRIDGE), Metaform allows you to create organic looking, "blobby" objects that flow together like globs of liquid mercury. It can create blobs from any 2-D profile, so your meta-balls do not have to be spheroid, as they must in Strata StudioPro. After a little trial and error, you will find that the "blobbiness" and radius adjustments offer good control of meta-ball appearance and behavior.
 - Particle tool includes a well-rounded assortment of options for controlling particle behavior. The particle tool lets you create jets and fountains of streaming particles, including smoke and fire. Separate adjustments for velocity, drag, gravity, and life span give you a good degree of control over particle behavior. Even better, any object can be designated a particle, so you can create, for example, spouts of stars or bubbles—or kittens.
 - Another new tool lets you build user-definable globular shapes from outlines (see "Blobs on Demand"); you can combine multiple outlines to create complex, flowing organic shapes, or draw out individual globules from a shape to produce an animated effect.
 - The materials palette provides larger previews and displays transparency controls.
 - Extreme 3D's™ materials browser now has transparency and luminosity controls for all basic shaders, and you can define the effects by color values or bit maps.
 - The program lets you edit ambient lights in the lights browser and adds controls for shadow resolution and fuzziness to spotlights and distant lights.
 - With the new version, you can choose either QuickDraw 3D or Extreme 3D's™ own interactive renderer.
 - The fast Phong renderer (for final rendering) now includes controls for gamma correction; it can also combine material transparency with shadows to produce effects normally possible only with ray tracing.

Disadvantages:

- Despite interface improvements, Macromedia should have gone further in simplifying Extreme 3D's™ tool set. Although the context-sensitive prompts help guide you through the multi-step modeling processes, many tools still feel somewhat nonintuitive; the user may find himself tunneling through dialog boxes and menus, looking for tool settings.
- The score window, which provides powerful key frame animation controls, should have been given a face lift. Essentially unchanged from version 1, it seems clunky and nonintuitive.

- The particle tool is powerful, but its fire and smoke effects are not quite believable and take a long time to render. You can improve your results by building custom texture maps, but for serious pyrotechnic endeavors, it is better to use a post-processing filter such as MetaTools' Final Effects.

- Like all other 3-D products, Extreme 3D™ is resource hungry: The PowerPC-only version occupies about 40 MB of disk space. Although the program can run with as little as 24 MB of RAM, you will want at least 32 MB for any serious projects.

- Macromedia has rewritten Extreme 3D's™ renderer to take advantage of the Power Macintosh's floating point processing. While that makes for more efficient rendering, it also makes the program Power Mac only.

- Extreme 3D™ takes time to learn.

3D Choreographer Deluxe 2.7 by Animated Communications

What is it?

3D Choreographer brings you the state-of-the-art technology necessary to create quality animation using a PC. The animation techniques are easy to learn, so you can create a high quality finished product quickly. The animations you create are appropriate for business or the classroom.

Rather than the creating PC animation on a frame-by-frame basis, 3D Choreographer enables you to think in terms of movement, not frames, providing a much more intuitive and natural method of creating animations. You simply specify commands for your animated actors to follow, and the program automatically generates the animation. If you decide to change your animation, you merely issue different commands. There is no art work to draw and no complex three-dimensional concepts to learn.

Classroom Use:

Creating 3D animations for use in

- presentations via presentation software or authoring tools,
- CBT, and
- web pages.

These files can be imported into any of the authoring tools or directly onto web pages designed within the classroom via Netscape Navigator™ Gold (available on the BRIDGE).

Functionality:

- Interoperability.

3D Choreographer files can be imported into any of the authoring tools and onto the web via Netscape Navigator™ Gold.

Advantages:

- Ease of use.
- Rather than the creating PC animation on a frame-by-frame basis, 3D Choreographer enables you to think in terms of movement. You simply specify commands for your animated actors to follow, and the program automatically generates the animation.

Disadvantages:

- Not for the professional.

Simulation and Prototyping Tools

One of these programs is available on the BRIDGE:

<u>TOOL</u>	<u>PROVIDER(S)</u>
Rapid™ 3.5	Emultek

Rapid™ 3.5 by Emultek

What is it?

Computer-Based Simulation. Allows users to embed fully functional interactive simulations within computer-based training applications created with CBT authoring tools. This facilitates training without needing to use the product itself, reducing training costs, improving retention through interactive testing and improving maintainability. Rapid™ offers the user the ability to “experience” the system or device without necessarily working with the physical product.

Non-programmers can quickly create courseware applications with full free play simulations. Rapid™ provides users with real-time practice. Free play simulation is the cornerstone of most training applications. Rapid™ allows developers to simulate any interactive system with the click of a mouse.

Classroom Use:

- Training via simulation of Army equipment or battle situations used in CBT or instructor-led training. Although Rapid™ is most useful to support technical training, representations of relevant equipment could be embedded into CBT for higher cognitive skills training.

Functionality:

- **Operating Style.** Rapid™ uses object-based interface technology to allow developers to quickly simulate systems. Creating a simulation with Rapid™ uses two main modules, one for defining the building blocks of the application being simulated and one for functionally linking these building blocks. A third module allows you to create your delivery system packed with CBT features. Runs on Novell Networks.

- **Programming Language.** No user programming is required.
- **Web.** With Raid Plus (not currently available on the BRIDGE), prototypes can be embedded in HTML files and viewed in Netscape Navigator™.

- **User Interactivity.** Rapid™ allows users to experience hands-on operations of the simulated product or tool, allowing for real-time training while saving money and time in the training process.

- **Interoperability.** Windows™ based. Rapid's™ built-in CBT features allow full multimedia support as well as seamless integration with leading authoring tools such as Authorware™, IconAuthor (not currently available on the BRIDGE), ToolBook, and Quest™ (interface software may be required).

Advantages:

- A true codeless environment for simulation.
- A library of customizable and reusable objects, including an object development kit.
- Rapid™ offers the ability to import graphics, animation, digital video, and sound from nearly any source.
- Full support of true color.
- User-defined objects (UDO). Create reusable compound objects from applications.
- Easy link with leading authoring tools.
- User-defined functions (UDF). Create your own group of functions that can be reused as needed.
- Runs on Novell Networks.
- 32-bit power.

Disadvantages:

- Requires training.

Pre-Authoring Tools

Pre-authoring tools assist in the project management and instructional design of computer-based training (CBT).

One of these programs is available on the BRIDGE:

<u>TOOL</u>	<u>PROVIDER(S)</u>
Designer's Edge™ 2.0	Allen Communications

Designer's Edge™ 2.0 by Allen Communications

What is it?

A pre-authoring tool for instructional designers. Helps accelerate the analysis, design, and evaluation of effective technology-based training. It is a visual, task-driven interface that walks users through the entire instructional design process from analysis to evaluation. Enhances productivity by providing dynamic tools for process acceleration and data organization, on-line instructional expertise, and extendibility features.

For lack of a better term or analogy, one might consider it a computer-assisted software engineering (CASE) tool for instructional design (ID). The tool spans the entire range of standard analyze, design, develop, implement, evaluate, maintain (ADDIE-M) instructional design model. Furthermore, it covers this range without forcing you to accept a particular ID philosophy or methodology.

Process Acceleration

Designer's Edge™ is the first integrated software to provide instructional designers with all the tools they need to build precise blueprints for technology-based training. Built by instructional experts to accelerate the process of creating interactive training, Designer's Edge™ offers a visual, task-driven interface that walks users through the entire instructional design process—from analysis to evaluation.

It enhances productivity dramatically for both experienced and novice designers by providing dynamic tools for process acceleration and data organization, unprecedented on-line instructional expertise, and powerful extendibility features.

Step-by-Step Guidance Through the ISD Model

Designer's Edge™ decomposes the development process into roughly 12 modules corresponding to the traditional instructional design model. Modules such as analyze needs, create audience profile, and evaluate course offer you canned forms (e.g., surveys for analyzing the proficiency level of your target audience) that you can customize. Designer's Edge™ uses wizards extensively to walk you through creating reports and for generating and organizing your objectives for the course. Finally, the program links to third-party applications for reporting, prototyping, flowcharting, and authoring.

At the heart of the package lies the layout course map module, in which you can also perform tasks associated with define treatment and select learner activities. Here, you build the hierarchical structure of your course; the layout module combines a multi-paned screen with tab access to the different elements involved (such as objectives and strategies) and lets you drag and drop your content onto the structure. The program includes a storyboard course module, in which you build mock-ups of screens corresponding to the items in the course map and compile lists of related media.

Designer's Edge™ encompasses every conceivable detail of the development process, including approval check-offs at every stage, and provides lots of advice about how to approach the different aspects of the job.

Designer's Edge™ is most useful for CBT design and development teams of six or more people and for any one person responsible for designing and developing more than 8 to 10 hours (15 or more lessons) of CBT per year. With a large team, this product helps ensure consistency across the project, regardless of who did what.

In addition, Designer's Edge™ helps with managing all the data from numerous lessons and courses. In either case, the organization will benefit by spending the design time in the beginning with this tool. Spending a little extra time customizing the tool for your particular needs is a wise decision. In no time, you will find that you have raised the quality, increased the consistency, improved the development efficiency, reduced costs, or maybe even made the training more effective.

Classroom Use:

Designer's Edge™ will help the user develop a layout and plan of action for training before an authoring tool is used (for development of CBT) or instructor training is delivered.

Designer's Edge™ helps you assess your audience, set objectives, and measure your students' (and your application's) success.

Functionality:

- Programming Language. No programming required.
- Interoperability. When you finish working in Designer's Edge™, you can press a button and (if you have the required utilities) export your work for use in Quest™Net +, Authorware™ (via Authorware™ Synergy) and ToolBook II (via ToolBook Synergy). Course maps, navigation, and all the storyboard content (backgrounds, buttons, sounds, and all text) become part of the application created automatically in the target authoring tool.

Advantages:

- Allen's engineers have "pumped up" what ostensibly looks like a cute little Visual Basic application in a robust, end-to-end instructional development tool.

- The interface not only provides quick access to the tasks and tools associated with a phase, but it also serves as a reminder of both the overall process and the relationship of your work to other phases.

- A training card helps coach you through the process. Even experienced designers may find the training cards helpful, but they can easily be disabled if they become a bother.

- Just as Designer's Edge™ does not constrain your instructional style, it does not confine you to a particular database format or office productivity suite. All printable files are provided as rich text format (RTF) files, so you can use the word processor of your choice to edit them or add new documents.

- Many audience survey questionnaires are included to support needs analysis. The form can be previewed from within Designer's Edge™ or opened from within your word processor for printing or editing. To print or edit, you just click on the "generate report" button.

- You can add your own forms just by saving them as RTF files and employing the customizer utility included with Designer's Edge™.

- Designer's Edge's™ report wizards are a blessing for the developer whose boss demands impromptu reports, for the hands-on client, and for the organized shop that likes to document everything. Some wizards, such as the draft mission statement's report wizard, primarily collate and format data entered or collected in earliest phases. This may sound trivial, but it can help a lot when you are trying to juggle a design and production schedule, as well as assemble all sorts of floating bits of data for a management report. These wizards benefit you most when you are serving as project manager.

- The Objective wizard is especially helpful when design and development tasks need to be heaped onto the schedules of already overburdened SMEs. This coaching not only helps the novice designer but also addresses the writer's block you face while searching for a unique verb describing your 237th performance objective. This kind of technology is bound to improve courseware by reducing the tedium of all those objectives stuck on the opening screens of CBT everywhere.

- Audience profile report wizard blends the point-and-shoot technology of the objective wizard with report writing and a knowledge of the forms or data used on a project. This wizard lets you check boxes and add comments to elaborate.

- The latter phases of design include tools to select instructional treatments and motifs (visual themes or interfaces). The tasks in these pre-authoring phases include links to external files, but the links are much smarter than mere bit map gatherers. These tools also link to external flowchart programs and authoring systems, such as Authorware™, ToolBook, or Allen Communication's Quest™.

- Although Designer's Edge™ defaults to using Quest™ templates, Allen generously provides the customizer application to allow you to design and author with your favorite multimedia authoring tools.

- Designer's Edge™ allows you to tailor the program to your design and development process. Customizer displays a Windows™ 95 "tree control" that lets you redefine phases and tasks.

If you do not like some of the forms, reports, motifs, or templates, you can add, trash, and modify them. You can edit the verbs and phrases used in the objective wizard, and the instructional strategies icon allows you to batch your own instructional strategies or treatments or map the existing ones to your Authorware™ models and libraries.

Disadvantages:

Note. It has been difficult to find anyone who has anything bad to say about Designer's Edge™.

- Designer's Edge™ is tied to the traditional systems approach to training development and design. This may impede the developer who is attempting to implement another instructional development strategy.

Concept Mapping Tools

Concept mapping tools capture ideas in a diagram form to aid in clarity of understanding, explanation, and documentation.

One of these programs is available on the BRIDGE:

<u>TOOL</u>	<u>PROVIDER(S)</u>
SMART Ideas™	SMART Technologies Inc.

SMART Ideas™ by SMART Technologies Inc.

What is it?

A concept mapping software. SMART Ideas™ allows a user to capture his or her ideas in concept map form, create a database of those concept maps, and present ideas to others with clarity, flexibility, and ease.

Concept maps are a means of presenting ideas and their associations graphically. They combine textual synopses of ideas with colorful visual symbols of those ideas in a way that makes one's train of thought immediately accessible to an audience. A concept map is composed of two elements: ideas and their connections.

SMART Ideas™ accommodates the dynamic process of brainstorming with an equally dynamic set of recording and editing tools.

SMART Ideas™ text is hypermedia, which enables one to create references not only to other ideas in the concept map database but also to Word documents, Excel spreadsheets, graphics, and multimedia files. By pointing and clicking on a symbol in a concept map, you can cause a document, formula, image, or sound to appear and provide an appropriate example or supporting detail.

In summary, SMART Ideas™ enables you to

- generate, record, and modify ideas quickly, either individually or as a group over a network;

- focus on developing your ideas without worrying about language concerns;
- focus on associating ideas and on discerning idea relationships and connections;
- assign meaningful symbols to ideas and associate them with descriptive links;
- expand or illustrate your idea database with Word documents, Excel spreadsheets, graphic, and multimedia files; and
- create an interconnected web of ideas with the referential power of the SMART Ideas™ database.

Classroom Use:

- make dynamic presentations with concept maps
- classroom brainstorming
- create and ideas archive
- clarify your thinking

Web Navigation Tools

Two web navigation tools are available on the BRIDGE:

<u>TOOL</u>	<u>PROVIDER(S)</u>
Netscape Navigator™ Gold	Netscape
Internet Explorer™	Microsoft

Netscape Navigator™ Gold for Windows 95/NT by Netscape

What is it?

Netscape Navigator™ Gold offers an interactive and open environment for communicating and conducting business on the internet or across enterprise networks. Netscape Navigator™ Gold

- enables the user to create, delete, and navigate live on-line documents;
- integrates WYSIWYG document-creation capabilities into Netscape Navigator™, enabling the user to publish content in real time, which can include live objects;
- enables seamless viewing of embedded multimedia objects;
- includes Cool Talk, internet telephone (voice communications), typed communication, and white board (typed or drawn communication) conferencing applications.
- seamlessly integrates secure point-and-click network navigation, e-mail, threaded discussion groups, file transfers, and other internet services and operates at 14.4 bps and higher speeds;
- permits the use of plug-ins that allow users to view objects such as Adobe Acrobat™ documents, Macromedia Director™ files, QuickTime movies, RealAudio sound files, and live video without requiring them to load a separate helper applications;

- adds plug-ins that support data streaming, which lets users play a multimedia object before the entire file is finished downloading;
 - provides on-line support for Java applets written in Sun Microsystems' JavaScript;
 - includes an integrated multipurpose internet mail extensions (MIME) (a new mail format standard that allows one to send graphics, web pages, presentations, and so forth, without losing the format of the original document), and embedded HTML (web page programming language) compliant e-mail application;
 - supports progressive JPEGs (a standard for binary files, most often used to send pictures), secure socket layers (protection for data sent over the internet through encryption), secure courier payment protocol, and digital ID services and file transfer protocol (FTP) (UNIXTM standard), Gopher (search engine used primarily in universities and libraries) and Newsreader internet (read Newsgroups, approximately 26K groups) tools;
 - enables users to enter text on a web page and assign attributes from a pull-down menu;
 - employs templates and a page wizard that walks users through basic web page creation;
- and
- lets users toggle between authoring and browsing modes and drag images from the WindowsTM Explorer file manager to web pages.

Classroom Use:

- develop class web pages.
- browse the web.
- e-mail and file transfers.
- view objects such as Adobe AcrobatTM documents, Macromedia DirectorTM files, QuickTime movies, RealAudio sound files, and VDO-Live video on the web.

Internet ExplorerTM by Microsoft

What is it?

Internet ExplorerTM offers an interactive and open environment for communicating and conducting business on the internet.

The Internet ExplorerTM 4 browser takes web navigation to a new level with the introduction of explorer bars. Appearing as a vertical pane in the left side of your browser, an explorer bar has four variations: search, favorites, channels, and history. Other key enhancements include improved font management, more web-centric printing options, and the slickest, most customizable interface imaginable. You have the option to install Active Desktop, which lets you extend the concept of the web browser to the operating system. You can then browse folders on your hard disk the same way you "surf" the web. You can convert your desktop folders and shortcuts to the single-click metaphor used on the web.

Internet ExplorerTM 4 adds a push client to its browser as well as to its off-line browsing capabilities. Again, the options for configuring the browser are unparalleled. For example, you

can specify which files to download by type, select how much to download and how often, or simply let Internet Explorer™ 4 notify you when the contents of a site have changed.

Classroom Use:

- develop class web pages.
- browse the web.
- e-mail and file transfers.
- view objects such as Adobe Acrobat™ documents, Macromedia Director™ files, QuickTime movies, RealAudio sound files, and VDO-live video on the web.

Productivity Tools

One productivity tool is available on the BRIDGE:

<u>TOOL</u>	<u>PROVIDER(S)</u>
Microsoft Professional Office Suite	Microsoft
• Word 97	
• Excel 97	
• Access 97	
• PowerPoint 97	

Microsoft Professional Office Suite by Microsoft

What is it?

Microsoft Professional Office Suite is considered to be the leader in office productivity tools offering Word 97 (word processing), Excel 97 (tools for analysis, model building, charting, worksheet presentations, applications development and the Internet), Access 97 (database package), and PowerPoint 97 (presentation tools).

Classroom Use:

Word 97:

- papers,
- handouts,
- memos,
- letters,
- HTML development.

Excel 97:

- pull data from the internet using Microsoft Query,
- analysis and charting of data,
- development of spreadsheet-specific HTML tags when Excel users are the target audience,
- simultaneous file access to data for on- and off-site students and instructors.

Access 97:

- create and maintain flat file and relational databases,
- output tables, queries, data sheets, forms, and reports to static HTML files,
- send output data to a web server (live web output).

PowerPoint 97:

- live multimedia presentations,
- create interactive, stand-alone presentations,
- export your presentations as web documents.

Word 97. Long the best balanced and most intuitive of Windows™ word processors, Microsoft Word is now also the most powerful. Microsoft Word 97's menus and keyboard are basically the same as they are in Word 95, allowing effortless upgrading, but Microsoft has enhanced virtually every other feature, sometimes spectacularly.

Word now stores multiple versions of a document in a single file, and desktop publishing features include the ability to make text flow from one box to another on a different page. You can use a new table-drawing pencil tool to create tables on the screen instead of needing a dialog box, and a document map now displays all headers in outline form (and lets you jump to any header simply by clicking on it).

Word's impressive features for quick formatting now include the abilities to let you apply bold face or italic to the first item in a bulleted list, as well as customized bulleting and numbering. The company has also eliminated annoyances in earlier versions of Word, such as a bulleting and numbering dialog that did not show your customizations. Powerful organizing features, such as cross referencing and numbering, now equal or surpass similar features once superior in WordPerfect.

Webmasters will find Word an almost complete tool for building advanced HTML pages. You can effortlessly create standard headings and layouts and build complex elements, such as forms, from a toolbar. However, you need to understand the technical details of HTML forms processing, and if you want to build HTML forms seamlessly, you should choose a dedicated package, such as Microsoft's FrontPage. Otherwise, Word includes tools for building almost everything imaginable on a web page, except frames and Java applets. For instance, you can add decorative horizontal lines and standard bullets using a menu, and you can have Word automatically convert internet addresses into hyperlink fields.

Also, Word now includes formatting features such as animated and blinking text. These resemble similar features you can build into HTML pages through Java or ActiveX applets, but

they appear only in documents you view in Word or in the free Word Viewer available from Microsoft's web site. When you export a Word document to HTML format, Word converts these features into ordinary text.

Word has finally begun employing Visual Basic for Applications as its macro language instead of WordBasic, and it automatically converts the macros from its earlier versions when you open a document or template containing them. However, a few hindrances remain from earlier releases: The master document feature continues to link awkwardly to the outline feature, and you still "menu hop" a lot if you want to create or modify styles by hand.

In addition, the view options dialog box may baffle even expert users because Word offers only options for the current view. You must close the dialog and change views before you can access all options.

These are small flaws in a package that ranks as the best word processor (and among the most powerful and elegant applications for WindowsTM) ever written.

Excel 97. The principal competitors facing Microsoft Excel 97 are Microsoft Excel 95 (also known as Excel 7) and Microsoft Excel 5. Convincing current customers to upgrade has become Microsoft's primary goal for Excel, toward which end, the company has equipped the latest version with a well-rounded set of improvements.

Users who want to fetch data from the internet or from a corporate intranet can take advantage of a new query feature. A web query, coded in a plain text Internet Query (IQY) file, attaches itself to Excel's data menu; it can contain parameters for obtaining particular data from a web site (e.g., a set of stock symbols) or can prompt you for specifics when you make a web connection. Excel comes with four sample IQY files, and others are available on Microsoft's web site. (Quattro Pro and 1-2-3 can also generate parameterized web queries, via their macro languages.)

To further the use of web queries, Microsoft has provided support for some new, spreadsheet-specific HTML tags. As a result, developers designing sites with Excel users in mind can feed web-query target fields into an Excel PivotTable or a filtered list. Like 1-2-3, Excel now allows reading and writing at internet sites, and it includes a special toolbar to facilitate web browsing. In addition, a new insert hyperlink command lets you "plant" links to the web or local files in worksheet cells.

On the work group front, Microsoft has adopted a model that explicitly supports simultaneous file access for workers both on and off site. Excel permits multiple users to edit a shared file simultaneously. (By contrast, 1-2-3 restricts all but one user to read-only rights.) When different editors enter conflicting changes in a document, Excel either accepts the last one or displays a dialog box that lets the user who made the last change decide. A change history feature records every edit with a user name and date, allowing an editor to restore original cell values and letting those working alone track their own revisions. However, Excel still lacks an easy-to-use, versatile scenario and version manager comparable to 1-2-3's.

Users can merge copies of a shared workbook with a new "merge workbooks" command. Excel resolves any conflicts using the same rules it employs for changes in a single file.

Excel's charting interface now fully aligns the menu system and chart wizard, so that each wizard dialog box has an exact menu counterpart. As a result, you can now employ the menu system for creating and editing charts.

In addition, PivotTables can now include calculated fields, and an external query operates as a separate thread, allowing you to continue working while tables are externally refreshed. Persistent formatting, structured selections, and correct sorting of dates take care of some petty irritations in previous versions' pivot tables.

You can also select charts for editing with a single click, and a clever binding box appears around those worksheet cells that contribute to a selected data series, allowing you to expand, contract, or modify the series by simply dragging the box or its fill handle.

Microsoft Excel 97 is clearly the most richly endowed spreadsheet that you can purchase. However, Excel 95 is arguably the second most richly endowed. Whether the new release is a compelling upgrade for you depends on whether you need its new features.

Access 97. With professional power, superb tools, and excellent integration with Microsoft Office 97, Microsoft Access 97 leads the pack in databases as the worthwhile choice for novice users or expert programmers.

Access's new internet support lets you output tables, queries, data sheets, forms, and reports to static HTML files, with or without using a template. You can also send your output to a web server, and Access will provide a mechanism for creating live web output. You can output database objects to dynamically updated live views on web sites hosted by Microsoft's Internet Information Server or personal web server. For moving in the other direction, you can import data from HTML tables or link or attach to an HTML table. This release also adds a native hyperlink field type that can link to HTML files or Office documents, whether stored locally or on the internet.

Access 95 pioneered the appearance of replication in a desktop database product. The latest version extends this feature to the internet, so you can keep your replica databases congruent using FTP. A new partial table replication feature lets you replicate a selected set of records rather than a whole table. The program's exceptional database engine, Microsoft Jet, supports many relational database necessities, such as real primary and foreign keys and advanced features such as updatable views. Because all access to data in an Access database comes through Jet, and because Jet always enforces the validation rules, these rules cannot be bypassed. This helps ensure the integrity of your data, even when access comes through external sources.

The form and report design tools in Access are first class. Tabbed property sheets, click-and-draw control palettes, drag-and-drop field lists, and right-click pop-up menus characterize the designers, while Microsoft's wizards and the autoform, autoformat, and auto report features

do most of the work for you. All forms begin life now as “lightweight” forms to enhance performance. This means a form will not have a Visual Basic module for applications attached until you write some code and it becomes necessary. Also new is Microsoft’s Office Assistant, a component shared with other Office 97 applications. The Assistant accepts your plain English questions and offers help and then occasionally offers tips or explanations.

Access includes a powerful suite of query facilities. For simple searches, you can use filter by form to turn your form into a template for requesting matches. Next is filter by selection, which lets you highlight the text you want to match. The advanced query facility lets you fill the query design view with search criteria and graphically join tables for multi-table queries. There is also filter by input, which lets you right click and enter search criteria in a text box on the resulting menu.

For developers, Access offers an enhanced Visual Basic for Applications language and development environment. All in all, Access impressively combines industrial strength database power with amazing ease of use.

PowerPoint 97. Whereas the previous version of PowerPoint felt largely like a port to the new Windows™ 95, Microsoft PowerPoint 97 comes armed with strong built-in HTML translation capabilities and impressive features for building stand-alone multimedia presentations. Add a first rate interface, Microsoft’s excellent on-line help, and a comprehensive and innovative feature set and you will find PowerPoint a truly worthy product.

PowerPoint’s built-in HTML translation lets you export your presentations as web documents instead of relying on the internet Assistant add-on. To perform the conversion, a wizard presents options (such as layout type and button colors) and graphically shows your progress. PowerPoint can also link objects with URLs. As a plus, it can save presentations into a special file that retains each slide’s transitions, sounds, and video effects. To view such a file on the web, users have to install a plug-in, PowerPoint Animation Player (available with Office and down loadable from Microsoft’s web site).

PowerPoint offers templates that let you simply enter data into attractive, professionally designed slides. To enhance your presentations even more, PowerPoint comes with a generous collection of clip art (applicable to the entire suite), and you can download more from Microsoft’s web site Clip Gallery Live. The program also does an excellent job of previewing graphics before you import them.

In addition, PowerPoint can customize a presentation for different audiences without resorting to multiple files, and it helps you rehearse and time your presentations. The autocontent templates rank as the most detailed and helpful (although Freelance tends to offer more selection). To help you use them as a starting point for your presentations, PowerPoint offers a wizard that steps you through the process. The program also has multimedia features that allow you to create interactive, stand-alone presentations, notably a tool for adding buttons that look as if they depress on screen.

PowerPoint does a good job of working with data tables as well. Asking you for the number of rows and columns before you enter data, it lets you enter text by just tabbing to each cell instead of having to change rows. In a welcome enhancement that originally appeared in Freelance, PowerPoint also displays thumbnail slides in your outliner, so you can view an entire slide as you change it.

Although PowerPoint lacks print preview, our black-and-white laser printer produced attractive output with smooth gradients and fonts, and the text was quite readable in gray scale form. If you need to take your show on the road, pack-and-go wizard conveniently copies your presentation and all necessary files to floppies so you can readily install on another system.

Freelance retains a slight edge in ease of use and group support, but PowerPoint is the strongest at setting up and displaying multimedia and creating interactive, stand-alone presentations. When you need to make your point, particularly with multimedia, this is definitely the way to go.

APPENDIX E
ACRONYM LIST

ACRONYM LIST

3DMF	3D metafile
AAN	Army after next
AAR	after-action review
AASLT	air assault
ACUMEN	advanced cognitive understanding of military environments
ADLP	Army distance learning plan
AEE	advanced experimental environment
AFST	aerial fire support team
ALE	advanced learning environment
ANOVA	analysis of variance
ANSI	American National Standards Institute
AOAC	Armor Officer Advanced Course
ARI	Army Research Institute
ARL	Army Research Laboratory
ARNG	Army National Guard
AT XXI	Army Training XXI
AWE	advanced warfighting experiments
BBS	brigade or battalion simulation
BCST	battle command staff training tool
BIG	beyond the information given
Bn	battalion
BOS	battlefield operating system
BPV Tool	battlefield planning and visualization tool
BRIDGE	battlefield-relevant instructional design guidance environment
BSTS	battle staff training system
CAD	computer-aided design
CALL	Center for Army Lessons Learned
CAN	campus area network
CAS ³	Combined Arms and Services Staff School
CASE	computer-assisted software engineering
CBT	computer-based training
CCTT	close combat tactical trainer
CD	compact disk
CEP	concept experimentation program
CGSC	Command and General Staff College
CIE L*a*b	<i>Commission Internationale de l'Eclairage</i>
CMI	computer-managed instruction
COA	course of action
COBRAS	combined arms operations at brigade level realistically achieved through simulation
COLT	combat observation laser team
Co/Tm	company or team
CPT PME	Captains' professional military education
CRI	criterion-referenced instruction

CTC	Combat Training Center
CTGV	Cognition and Technology Group at Vanderbilt
D&SABL	Depth and Simultaneous Attack Battle Lab
DIS	distributed interactive simulation
DIVARTY	division artillery
DL	distance learning
ELO	enabling learning objective
EPP	extended planning period
EPS	encapsulated postscript
EW	electronic warfare
FA	field artillery
FAOAC	Field Artillery Officer Advanced Course
FASCAM	family of scatterable mines
FASP	field artillery support plan
FDO	fire direction officer
FIST	fire support team
FM	field manual
FMFRP	Fleet Marine Force Reference Pamphlet
FRAGO	fragmentary order
FS	fire support
FSCAOD	Fire Support and Combined Arms Operations Department
FSCM	fire support coordination measures
FSCoord	fire support coordinator
FSE	fire support element
FSO	fire support officer
FSP	fire support plan
FTP	file transfer protocol
FY	fiscal year
GIF	graphics interchange format
GUIDE	guidance for understanding instructional design expertise
HTML	hypertext markup language
IAW	in accordance with
ICW	interactive courseware
IFSAS	initial fire support automated system
IPB	intelligence preparation of the battlefield
IQY	internet query
ISD	Instructional Systems Design
JA	joint applications
JPEG	joint photographic experts group
JRTC	Joint Readiness Training Center
KEI	key enabling investment
LAN	local area network
LIC	light or heavy forces in conflict
LRG	large file mode
MACOM	major Army command
MB	megabytes

MDMP	military decision-making process
MFOMS	MLRS family of munitions
MIDI	musical instrument digital interface
MIME	multipurpose internet mail extensions
MLRS	multiple launch rocket system
ModSAF	modular semi-automated forces
MOUT	military operations on urban terrain
MTC	movement to contact
NBC	nuclear, biological and chemical
NSFS	naval surface fire support
NTC	National Training Center
O/C	observer or controller
ODBC	open database connectivity
OPLAN	operation plan
Opns	operations
OPORD	operation order
(P)	promotable
PC	personal computer
PE	practical exercise
PDF	portable document format
PILOT	personal instruction and learning orientation tool
PNG	portable network graphics
POI	program of instruction
POM	program objective memorandum
RAM	random access memory
RGB	red, green, blue
RSOP	reconnaissance, selection, and occupation of position
RSR	required supply rate
RTF	rich text format
SASO	stability and support operations
SGT	staff group trainer
SIMNET	simulation network
SME	subject matter expert
SOP	standing operating procedure
SQL	structured query language
STOW	synthetic theater of war
TA	target acquisition
TADSS	training aids, devices, simulators, and simulations
TASS	total Army school system
TDMP	tactical decision-making process
TF	task force
TIFF	tagged image file format
TLO	terminal learning objective
TRADOC	U.S. Army Training and Doctrine Command
TOC	tactical operations center
TSP	training support package

TTP	tactics, techniques, and procedures
TVA	target value analysis
UDF	user-defined functions
UDO	user-defined objects
URL	uniform resource locator
USAFAS	U.S. Army Field Artillery School
USMC	U.S. Marine Corps
VCR	video cassette recorder
VRML	virtual reality modeling language
VTP	virtual training program
WIDD	Warfighting and Integration Development Directorate
WIG	without the information given
WYSIWYG	what you see is what you get

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